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LAND USE AND SERVICE REQUIREMENTS IN BRITAIN

TO the first of the two critical questions arising out of the Services' requirements for land the promised White Paper on the "Needs of the Armed Forces for Land for Training and Other Purposes" (Cmd. 7278. London : H.M. Stationery Office, 1947. 4*d*. net) gives a reasonably satisfactory answer. A total area of just over a million acres—702,000 for training and 325,000 for other purposes, which include airfields, barracks, defence works, radar installations, and Ministry of Supply purposes other than airfields—represents about one acre in every fifty-six and does not seem an excessive proportion to be set aside for purposes of national defence. Moreover, while the Government recognizes that even this modest total involves asking the nation to make some sacrifice of wealth, recreation and enjoyment, the reasons why more land is required than in pre-war years are set forth clearly and persuasively.

It is important that the new factors in this demand, such as the consequences of the increased turnover of men under training due to the continuance of national service, the larger space required for manœuvre and for the use of modern weapons, and the effect of training various arms in co-operation with live ammunition, should be plainly stated and recognized widely. Any sacrifices which the nation is called upon to make for such reasons must be patently justified and the area of unavoidable encroachment kept as small as possible. The White Paper is, however, much less convincing in its exposition of the reasons why training overseas is impracticable or why more training could not be done in Scotland or Northern Ireland. The very fact that, as the White Paper admits, training of the regular army is actually taking place abroad to some extent and will do so for some time to come, goes to undermine the main contention. Whether the continuance of training abroad would adversely affect recruitment is open to doubt, and does not affect the argument that some training of the regular army could, and probably must, always take place overseas. The White Paper only weakens the case by its emphasis on the redisposition and reorganisation of training establishments which would be required in the event of war if the bulk of such training were carried out overseas. Redisposition and reorganisation in emergency are inescapable, whatever policy is adopted, and here and elsewhere the White Paper betrays a regrettable lack of the wide vision and sense of proportion which are needed to eliminate the suspicions and misunderstandings already engendered by official actions, and to take full advantage of the goodwill and general understanding of the situation which is so widely apparent throughout the country.

Nor is the White Paper happier in its observations upon the unsuitability of Scotland as a training area. The disproportion between the 33,000 acres claimed by the Services in Scotland and the total of 702,000 acres in Great Britain is too pronounced to be brushed aside by such slender arguments. The objections will

have to be supported by much more convincing reasons if the public is not to believe that the examination of possible areas in Scotland has not been somewhat superficial, or that the attractiveness of proximity to greater amenities in southern Britain has not considerably influenced the decision.

On the question of the total land requirements, the White Paper is reassuring; on the choice of training areas within Great Britain, however, it does little to meet the substance of current criticism of piecemeal action. To the question of what land is to be chosen it gives no answer; and the procedure for examining individual proposals by Service departments gives no indication that the problem will be looked at as a whole and decided from a national, and not a departmental, point of view on any particular issue. It is true that the White Paper provides a comparatively firm basis for argument for or against any specific project; but the procedure proposed affords no adequate guarantee that decisions will ultimately be determined with reference to the best use of the land of Great Britain as a whole. Nor is it easy to see how such assurance will be forthcoming while the Government persists in its refusal to treat claims for land on the same basis from whatever source they come, and to insist that the Services, and other Government departments, provide fully substantiated reasons for particular proposals at the time when they are advanced, and not afterwards in deference to public protest.

In outlining the proposed procedure, which has already been indicated in some detail by the Parliamentary Secretary to the Ministry of Town and Country Planning in a debate in the House of Commons on November 26, the White Paper gives as one of the main reasons for the time taken in coming to final conclusions about Service land requirements the continuing review of particular proposals with reference to the dependence of the nation upon home agriculture, the vital importance of home-grown timber, the need to maintain unpolluted sources of water, fisheries and the recreational value of the countryside. The Government affirms its desire to make sure that both local authorities and amenity societies have full opportunity to make representations upon the effect of the proposals on the public interest they represent; and the regional consultations by the Ministry of Town and Country Planning with the local authority and water supply interests, and by the headquarters of that Ministry with amenity and scientific societies having no regional organisation, are intended to ascertain and resolve so far as possible objections advanced against particular proposals. The proposals are then considered by an interdepartmental committee in the light of objections expressed by any Civil department and of representations made in the previous consultations and reports submitted for the consideration of Ministers.

These consultations and consideration of the reports of the inter-departmental committee may lead to a decision, presumably by Ministers, though whether at Cabinet-level is not indicated by the White Paper, that the Service departments proposals must be abandoned. With other proposals there may be no objections, or modification may eliminate all substantial opposition If, however, substantial objections on grounds of the public interest still remain, a public local inquiry will be held, subject to security considerations, to hear and report on objections raised on grounds of public interest, national or local, whether by local authorities, water supply undertakings, amenity societies, or other bodies, and on representations of scientific or archæological societies against curtailment of opportunities for scientific investigation, such as bird-watching, or damage to areas of unique scientific interest. This inquiry will be presided over by a person selected by the Ministry of Town and Country Planning or by the Secretary of State for Scotland on the basis of his experience and standing in public affairs. Thus it would appear that in general there should be reasonable opportunity for objections to be raised on scientific and other grounds to particular proposals before they are too far advanced. Suggestions for the use of specific areas in the same general locality as alternatives to those under inquiry will be admissible, but not general arguments, such as that the requirements should be met in some other part of the country or abroad. Although the intention of the latter restraint is not so much to limit discussion as to prevent repetition tending to prolong the inquiry without benefit, the effect of this restraint may well be, under the existing conditions, to undermine some of the general goodwill and understanding essential to a satisfactory settlement.

On that ground alone it is important that there should be full discussion of the matter in Parliament before the proposed procedure and the general principles indicated are irrevocably adopted. The debate on the second reading of the Requisitioned Land and War Works Bill on December 16 illustrates the value of such discussion. Mr. Glenvil Hall had no difficulty in showing that the Services cannot fairly be blamed for all the delay in working out their permanent requirements, or that there are reasonable grounds for extending the period during which Service departments could exercise their wartime powers on land requisitioned for military purposes. None the less, it was manifest that there is a feeling that the extension of four and a half years requested is excessive, and some instances were cited of unreasonable delays.

Naturally enough, the debate involved some discussion of the White Paper, but the core of the criticism centred around two points: the effect of the Bill and of Services' demands for land on the position of the National Trust and on the proposed national parks. Speaker after speaker testified to the unfortunate effect of the encroachments on National Trust properties, and of the failure of the Services to relinquish such encroachments and to restore them with the utmost dispatch. There may be sound reasons for making some new provision for consideration by an appropriate Government authority, for example, the Minister of Town and Country Planning, of any property offered to the Trust, before it is finally accepted; but once accepted, that property

should be inviolable by the Services or by any other department. The National Trust does not act without full and careful consideration of the real significance to the nation of the properties for which it accepts responsibility; and it should be possible to recognize acceptance by the Trust as a final decision.

A firm declaration by the Government that National Trust properties would in future be inalienable, and that all those properties which are still requisitioned would be released immediately and repaired where necessary, would do much to engender confidence and to dispel the uneasiness and atmosphere of suspicion with which proceedings and discussion on the Services' land requirements have been accompanied. If this undertaking was paralleled by action to implement the recommendations of the National Parks Committee's reports, there should be a profound change in the whole atmosphere and little difficulty in reaching an amicable agreement on particular proposals. While such action is delayed, it is well to remember the observation of the Hobhouse report, which Mr. Turton quoted in the debate: "It would be no exaggeration to say that the appropriation of a number of the particular areas now listed for acquisition of the Service Departments would take the heart out of the proposed National Park areas in which they are sited, and in certain cases render our proposals for the designation of individual National Parks entirely nugatory".

That is one of the main reasons for the alarm which the Services' proposals for training areas occasions and the opposition which they arouse. The recent instance of the rifle range at Thorpe Oland, in Dovedale, shows that the Army is quite able to come to a reasonable compromise if its real needs are recognized; but this example also demonstrates the importance of meeting such proposals with a firm body of representative opinion. Meanwhile, it will be noted that, in concluding the debate, the Solicitor-General avoided any reply to the specific questions put regarding both national parks and National Trust property. The Government will do well to think again here, particularly as public confidence in its good faith received a severe shock in the refusal in the White Paper to honour the pledges given during the War in the Stamford and Purbeck areas that persons required to leave their homes should be allowed to return at the end of the War. To refuse to regard as binding such war-time promises is bad statesmanship, and goes far to undo any good that the White Paper and the recent debates have done. The main considerations should, however, be given urgent attention. Public inquiry into disputed claims on land should be held before, and not after, any proposal comes before the Interdepartmental Committee. The position of the National Trust properties should be made unassailable and the national parks legislation introduced. Finally, all Government departments and other public bodies should be obliged to submit their proposals for the utilization of land to a vigorous, independent and public scrutiny, backed by a competent authority at Cabinet-level, to ensure that national more than sectional and local interests determine the decision.

CHRONICLE AND COMMENTARY

The Intelligent Man's Guide to the Post-War World

By G. D. H. Cole. Pp. 1143. (London: Victor Gollancz, Ltd., 1947.) 21*s*. net.

Farewell to European History

Or the Conquest of Nihilism. By Alfred Weber. Translated from the German by R. F. C. Hull. (International Library of Sociology and Social Reconstruction.) Pp. xx+204. (London: Kegan Paul and Co., Ltd., 1947.) 16*s*.

THE lecturer or tutor who tries to guide his university extension or other students through the mazes of contemporary political and economic issues has long been accustomed to being asked to recommend a book which would cover the ground of his course and serve as a general reference work; and he has not infrequently named one of the books, packed with useful information, which Prof. Cole has found time and energy to produce as the offshoots of his own varied studies. Three major productions of this kind appeared before the War, and the "Guide to Modern Politics" of 1934 is still remembered. But never before has Prof. Cole produced so tightly packed a guide as has now appeared: the information it contains almost overflows as one holds the book, and the table of contents reads like an encyclopædia. There is ample material here for the study of almost every aspect of current problems —population, industrial development, international trade, unemployment, emigration, capitalism and socialism, developments in Britain, in Europe and throughout the world, the United Nations, and the future of democracy. The reader is at a loss whether to admire more Prof. Cole's width of reading or his powers of exposition. The select book-list alone, which runs to something over ten pages, would keep several tutorial classes busy for years, while there is valuable material in the long and well-devised series of tables and charts.

But while one salutes with respect the tremendous labour that has gone to the making of this vast work, only to be compared among recent books, perhaps, with John Gunther's "Inside U.S.A.", at the same time it is necessary to ask what purpose it is intended to serve. The publisher's introduction calls it "a great political self-educator", and if one accepts the view, not unknown among librarians, that the true needs of adult education can be met merely by making books available, then the description is a sound one, though the size and price of the book are somewhat forbidding. Prof. Cole himself is frank in his preface about the task he set himself. Much of the book had to be rewritten several times, he tells us, much of it discarded as centres of interest fluctuated, and in the end he let the printers have it in March 1947 in the hope that the selection of topics made "will give most readers as much of what they want as it is possible to bring between the covers of an exceptionally fat volume".

The disadvantages of this method of work are obvious, and the method itself can only be justified if the resulting book has something new to offer, whether by way of material or by way of interpretation. In the matter of material it may be doubted in this case whether anything new is presented, and it is not too much to expect that the student who would be prepared to sit down to a

book of this size would be equally prepared to do the wider reading that is necessary for the study of whatever topic particularly interests him. There is no dearth of useful reading matter, as Prof. Cole's book-list alone shows. It is rather interpretation that is required, and interpretation that could reasonably be expected, from a work that proclaims itself a "Guide". But interpretation in such a work implies the illumination of historical processes. There is much of this, but it is directed less to a clarification of issues than to a statement of Prof. Cole's own views, and even Prof. Cole cannot always speak with the authority of personal investigation. Thus he frankly tells us on p. 845: "I am neither a prophet nor an expert on Indian affairs, and any comment I make can be no more than that of a diligent observer of world politics", but proceeds: "I acutely dislike the idea of a completely separate Pakistan, because it seems to me to stand in the way of effective measures to raise the standards of living among the unfortunate Indian peoples, Hindu and Moslem alike", which illuminates his own views but scarcely those of the people concerned. Again, in discussing English education, he says: "The Education Act of 1944 purports to be a democratic measure; but it will not work out democratically unless a real effort is made to staff and equip, and as soon as possible to build, the new secondary schools up to a standard of real parity with the grammar schools and the so-called 'public schools'", which is so obviously true as scarcely to need saying but suggests that a "real effort" is not being made; while the attack that follows on "classics" and reactionary headmasters is good electioneering but not very sound as commentary on present developments. On the other hand, there are a number of revealing statements that repay careful thought, such as that "British social history was thus, like British political history, a process of gradual democratisation of what were at the outset essentially aristocratic institutions"; or again, that "there is, in effect, no real school for democracy except the school of action", which might serve as a text on English social development.

But perhaps it is in a remark on p. 288 that Prof. Cole most clearly reveals the limitations of his approach. "England", he says, "for reasons which it would take too long to explain, emerged from absolute monarchy into an aristocratic system in which the aristocracy did not form a closed caste, but mingled with, and recruited itself from, the developing plutocracy of commerce." It is precisely the reasons that are here left unexplained, and others like them, that the student needs to know if he is to make sense of the present confusion. To have the immediate background available is useful, though it can fairly easily be gathered together from a number of reliable sources; but it is in discerning processes at work over a long period that the 'intelligent man' requires guidance. In particular he will ask whether the two wars of this century have played any part in hastening or hindering recognizable historical processes, and a guide to the present discontents might well attempt to estimate the effect of the late struggle on world developments. The impact of the War, for example, on Great Britain, the United States and the U.S.S.R., on Germany, and on the peoples of Asia would repay close attention. These topics are not ignored; but the total effect emerges only indirectly from Prof. Cole's survey. It is as if he were writing only a sequel to the "Guide" of 1934 and noting that some important incidents had occurred since that book appeared; as if little distinction were to be drawn between pre-war and post-war. Without going all the way with the writer of another recent book who sees the war as a "watershed" in modern history, one may legitimately ask for some estimate of its significance, so far as that can be measured at this early stage. Yet it would almost seem that Prof. Cole is more concerned with the dangers of a Third World War than with the consequences of the Second. To say this is not to fall into the common error of blaming an author for writing his book as he saw it rather than as the reviewer would wish it to be. A work that sets out to be a "political self-educator" must seek to anticipate the questions that the intelligent student will ask.

It might be added that the book-list, from the very fact of its length, would benefit by having the guiding principles of selection stated, together with some notes on the books named, while it also needs slight correction in detail—for example, the books by Sir Reginald Coupland and Prof. E. H. Carr are wrongly described on p. 1100.

Dr. Alfred Weber's book, "Farewell to European History", stands in direct contrast to Prof. Cole's, and were it written—or translated—in an easier and less allusive style might be regarded as a valuable supplement to his. For it sets out to do what Prof. Cole has not done, to grasp the nature and spiritual content of the War seen as "an event that would fundamentally affect the further course of history".

Dr. Weber, brother of the better known Max Weber who died in 1920, was deprived of his post by the Nazis and lived in retirement until the end of the War, when, with this searching study in his hands, he turned again, in his eighties, to the task of upholding the traditional standards of German scholarship. The opening paragraph of his introduction: "For anyone endowed with historical perspective it must be clear that the catastrophe we have lived through and are still living through sets us at the end of History as we know it, that is to say, history as moulded by the civilization of the West", inevitably recalls the thesis put forward by Spengler during the First World War. But Weber's concern is with Germany's terrible part in the crimes that have been committed, and he frankly accepts her fearful load of responsibility, recognizing that "she will never again become a sovereign, autonomous, competitive Power State in the earlier sense". The origins of the horrors of recent years he traces in the developments that marked the nineteenth century, and especially in the nihilistic temper, associated in the popular mind with Nietzsche, that conquered the older spirit of the West from about 1880 and eventually provided the conditions that made Nazism possible. On this theme Dr. Weber has much that is illuminating to say, and it is of particular interest that it should be said in Germany at this moment by one who represents in himself something of the older spirit that was so tragically engulfed. For the future he sees a revival of traditional Western ideas, based on "national cultures with *intellectually* free sovereignty, but no freely competing nation-states any more". In other words, it is the form and not the spirit of the West that is to pass away, a conclusion that is certainly not one of despair.

The publishers are to be congratulated on making this important work available in an English translation.

MAURICE BRUCE

THE LIVING PLANT

Botany of the Living Plant

By Prof. F. O. Bower. Fourth edition. Pp. xii + 700. (London: Macmillan and Co., Ltd., 1947.) 36*s*. net.

THE veteran author of this well-known book must be warmly congratulated on the publication of its fourth edition. He has been fortunate in the selection of those who have aided him, Prof. J. M. F. Drummond and Dr. G. Bond in the third edition, and now Prof. C. W. Wardlaw in the present one. When the book first appeared in 1919, Prof. Bower was one of the few persons competent in Great Britain to write, single-handed, a general treatise on botany at the university level of instruction; but the time is rapidly approaching when the single author must give place to a team of collaborators. This difficulty has been forestalled by Prof. Bower in his admirable choice of assistants, and fortunately the homogeneity of treatment characteristic of the first edition has been maintained.

The general plan of the book remains the same as in the third edition, which was reviewed in *Nature* (**144**, 400; 1939), but there are considerable alterations in the section on Thallophyta, in which the terminology has been modernized and the treatment of certain groups expanded. In the chapter on the Chlorophyceæ it may be noted that the cause of red snow in high latitudes is *Chlamydomonas nivalis* and not *Sphærella pluvialis*. Attention is rightly directed to the difficulty of drawing a line between the Flagellata and the Algæ; there is an interesting new commentary on alternation of generations in the Algæ, and also a fuller discussion of this in comparison with alternation in the higher plants.

Further information is given about the multifarious spore forms of the Fungi. Included in this section is a comprehensive account of the life-history of *Puccinia graminis* in the light of modern work, though an error still persists concerning the time of nuclear fusion, which occurs during the maturation of the teleutospores and not on germination. It might have been pointed out that this fungus is now something of a rarity in Britain, although other cereal rusts occur frequently: so uncommon is it that many teachers of botany are at a loss for material. A mistake concerning *Phytophthora infestans* should be corrected: it is not true to say that the mycelium spreads through the tissues down the haulms to the tubers.

The stimulus which this book has always given to the study of plant morphology is further enhanced by a new discussion on the nature of the leaves of Dicotyledons and Monocotyledons, by insistence on the sporangia of the higher plants being organs *sui generis*, and by reference to the category of 'telome' introduced by Zimmermann. The chapter on "The Relation of Size and Form in Plants" has been elaborated, and it now contains a most interesting comparison of the apical growth of palms and ferns in relation to the vascular supply and nutritive requirements, which is contrasted with development in the Dicotyledons. This chapter also contains an illuminating statement on adaptation of form in submerged parts.

There are a few new illustrations, notably the frontispiece, which is a modern picture of the giant trees of California, replacing an older representation.

All teachers of botany will offer the heartiest welcome to this new edition, which will give the book a fresh lease of vigorous life. Among other noteworthy features which have been maintained is the unsurpassed exposition of the biological significance of the development of heterospory and the seed habit.

F. T. BROOKS

SAMPLING PRACTICE IN THE UNITED STATES OF AMERICA

Méthodes statistiques modernes des administrations fédérales aux États-Unis

Par Pierre Thionet. (Actualités scientifiques et industrielles, 1011.) Pp. 117. (Paris: Masson et Cie., 1946.) 250 francs.

THIS book reviews recent American developments in the application of sampling to the collection of economic and demographic statistics. It is divided into two parts: the development of the mathematical theory, and the applications which have been made in recent years. On the practical side, chapters are devoted to the sampling methods applied to the 1940 Population Census, the methods adopted in the construction of monthly labour statistics, and the development of sampling methods, including the master sample, in agricultural statistics. On the theoretical side, an endeavour is made to cover the whole of the modern developments of sampling theory.

The book is useful in that it gives under one cover a summary of the very impressive progress that has been made in the United States. Accounts of most of this work have only been published after the outbreak of the Second World War, and are therefore likely to be less available, and less well known, than would otherwise have been the case. The importance of making these developments widely known in Europe, where the application of sampling has lagged behind that in the United States, cannot be too widely stressed.

On the other hand, the book must be regarded as a review of what is going on rather than as a satisfactory text-book from which to learn the new methods. Although half of the book is devoted to the theory of sampling, the presentation leaves much to be desired, and it is clear that the author has not fully digested the more modern developments. Thus, for example, he appears to have no understanding whatsoever of the analysis of variance, although he devotes a section to it, and later reproduces a schema for such an analysis. He also appears to be unaware of the connexion between the analysis of variance and intraclass correlation, a point which he could scarcely have overlooked had he studied Fisher's "Statistical Methods for Research Workers", which introduces the analysis of variance *via* intraclass correlation. Again, what is one to make of the recommendations in the chapter on basic theory that, in the absence of all information on the size of the different strata, the population mean should be estimated from the mean of the strata means, and that an equal number from each stratum should be included in the sample?

Whether the book will be of much value to English-speaking readers, who can easily refer to the original papers (most of which have been published in the *Journal of the American Statistical Association*), is therefore doubtful; but for those who require an introduction to the subject in the French language it will fulfil a useful purpose.

F. YATES

BLINKING: ITS ROLE IN PHYSICAL MEASUREMENTS

By Dr. ROBERT W. LAWSON
Department of Physics, University of Sheffield

Introductory

A BLINK is defined as a temporary closure of both eyes, involving movements of the upper and lower lids. The process of blinking may be carried out voluntarily; but in what follows we are primarily concerned with normal *involuntary* blinking. As a result of a study of the literature on this subject I have become aware of an important consequence of this lid movement which has unexpected repercussions on many phases of human activity, and which does not appear to have been recognized or appreciated hitherto. During part of the duration of each blink we undergo a complete blackout, and this has an important bearing on the accuracy attainable in a variety of physical measurements. That it has not been taken into account in the past is undoubtedly due to the involuntary nature of the act of blinking, for I find that relatively few people are aware of the blackout interval, and those who are rarely have any idea of its duration, believing it to be instantaneous. Moreover, the normal rate of blinking or the converse inter-blink period is not generally known, except in medical and kindred circles. In physics the various subjective errors of measurement have usually been considered to be taken account of adequately by the use of the personal equation. But it is now clear that the blackout factor during blinking must also enter into the personal equation, and it has to be recognized that in certain types of measurement it is, in fact, the dominant part of that equation. Before discussing this feature of the process in greater detail, it will be helpful to summarize the literature on the subject of blinking[1], in so far as it is relevant to this discussion.

Blinking

(*a*) For the normal individual, provided that the experimental conditions remain constant, the average value of the interval between successive blinks (*inter-blink period*) is remarkably constant, though four different types of blinking have been recognized. In the first and predominant '*J*-type', short inter-blink periods are common, the average inter-blink period being *c.* 2·8 sec. for men, and somewhat less than 4 sec. for women. In the second, 'plateau type', the average inter-blink period was found to be *c.* 12 sec., though most of the observations were on women subjects. For the third, 'bimodal type' (uncommon), the average period was 3·6 sec.; and for the fourth, 'asymmetrical type' (very uncommon), 5·8 sec. Dryness or humidity of the atmosphere have little effect on the rate of blinking. The value of the inter-blink period in the dark is inappreciably higher than in the light, though a sudden intense light may produce initially a few rapid blinks. The rate of blinking is more rapid when the eyes are converging on a near point than when they are focused on a distant object or moving from point to point. Attempts to stop the lid movements voluntarily lead in a short time to an almost irresistible impulse to blink.

(*b*) "The rate of blinking is closely related to the 'mental tension' of the subject at the time, and in all probability the movements constitute a kind of relief mechanism, whereby nervous energy, otherwise unutilized, passes into a highly facilitated path[1]." When the mind is in a state of relaxation, so that the mental tension is at a low level, there is little need for relief and the rate of blinking is slow, as it is also in the process of solving a mathematical problem, when, although there is intense mental activity, the mental tension is diverted into internal channels. On the other hand, when there is mental tension with no internal or external outlet for its relief, there is an "overflow of nervous energy into facilitated paths", which manifests itself in an increased rate of blinking. As instances of this enhanced rate of blinking or diminished inter-blink period may be cited impotent rage, anxiety with inactivity, suppressed pleasure or excitement, legal cross-examination, animated conversation, and frequent changes in fixation, where blinking tends to eliminate the disturbing blurring of the retinal image during the actual movements of the eyes.

(*c*) The sensory blinking reflex is brought about by an irritative stimulus such as the contact of a foreign body with the lashes, cornea, or conjunctiva, or by an irritation of these parts. The reflex time of the sensory reflex seems to be of the order of 0·04 sec., and the completion of a reflex is followed by a refractory period, lasting 0·25 sec., during which a second stimulus is ineffective. The effect of currents of air is to increase the rate of blinking, and particles of dust in the eyes have the same effect. Smoking a cigarette held between the lips may reduce the inter-blink period to less than one-half the normal value, whereas in pipe-smoking less smoke enters the eyes, and I have found that the inter-blink period in this case is only reduced by 16–40 per cent.

(*d*) The optical blinking reflex is a completely different mechanism from the sensory, being brought about by a bright light, though it is best studied by bringing an object near to the eye without touching it. Here the reflex time is greater, being of the order of 0·1 sec. or slightly more, whereas the refractory period, during which a second stimulus is ineffective, is also longer than for the sensory reflex, amounting to 0·5–1 sec.

(*e*) The aural blinking reflex is initiated by mechanical or thermal stimulation of the ear, and is accompanied by unilateral weeping. Loud noises produce a similar effect.

(*f*) Various estimates have been made photographically of the duration of a full blink, and these lead consistently to values of 0·3–0·4 sec. Ploman, Engel and Knutsson found the duration of a blink (0·4 sec.) to be resolvable into the following intervals: lowering of the upper lid, 0·05 sec.; lids closed, 0·15 sec.; raising of the upper lid, 0·20 sec. (see Duke-Elder, p. 647). From these estimates it seems fairly certain that on the evidence available the time during which the pupils of the eyes are covered by the lids cannot differ appreciably from 0·3 sec., and this value will be used in the sequence. In other words, *during each full blink there is a complete blackout for a period of* 0·3 *sec.*

(*g*) In a publication on eyeball reflex movement associated with blinking, Miles[2] writes: "It was found that synchronously with the lowering of the upper lid there was a very rapid elevation of the eyeball with a much slower reverse movement when the lid was lifted. This movement of the eyeball appears in both reflex and voluntary winking and seems not to depend on the condition of sleepiness. In cases where the lid reflex is small, practically the complete curve for the cornea movement is recorded.

The size of the movement is of the order of 10 to 15 degrees on the arc of vision." "To what extent this shifting of the line of regard modifies the efficiency of vision has not been determined. Under certain lighting conditions one can easily notice the shift in the stimulus, a tailing off downward, at the instant of winking." This last statement is expressed in a somewhat different form by Macleod[3]: "If one notices carefully, one can observe while reading, that just at the beginning of the wink reflex it appears as if the page were suddenly jerked downwards".

In regard to this downward displacement at the moment of blinking, mentioned by Miles and Macleod, I have strong experimental evidence, to be published shortly, that it is due to another cause and not to the upward rotation of the eyeball accompanying the closing of the lids. Moreover, although an opposing motion of the eyeballs undoubtedly does occur during each phase of the act of blinking, experiments that I have conducted over a number of years have convinced me that, in general, the amount of the rotation is much less than the 10°–15° stated by Miles. Thus, in the case of my left eye, there is no perceptible rotation at all, whereas the magnitude of the rotation of my right eye is between ½° and 1°, and I have recently met with a case in which there appears to be no rotation in either eye associated with the lid movements. Furthermore, I find that as the edge of the upper lid crosses the pupil just before and just after the blackout period, there is *mobile vision*, a variety of autokinetic perception, which lasts about 0·01–0·02 sec. in each case. In contrast, the type of vision that occurs during the inter-blink period may conveniently be termed *static vision*, and it is then that the vision is most efficient. When a single act of blinking has been completed, the eye returns to its original direction of fixation, and in my own case this occupies a time of from 0·2 to 0·25 sec. The blackout period (0·3 sec.) is thus followed by a period of 'mobile vision' of approximate magnitude 0·25 sec.

The Blackout Indices

The above results, taken in conjunction with the value of the inter-blink period, have some important consequences, and it will be found convenient in their discussion to introduce at this stage the terms 'blackout index' and 'modified blackout index'.

(1) The *blackout index*, expressed in per cent, may be defined as one hundred times the ratio between the blackout period (0·3 sec.) and the inter-blink period (2·8 sec. for the prevalent '*J*-type' eye—see (*a*) above). This means that under normal conditions a person with a *J*-type eye is 'blacked out' intermittently for 10·7 or say 11 per cent of the total time of vision.

(2) The *modified blackout index*, expressed in per cent, may be defined as one hundred times the ratio between the sum of the periods of blackout and mobile vision (0·3 sec. + 0·25 sec. = 0·55 sec.) and the inter-blink period. This means that under normal conditions a person with a *J*-type eye has uncertain vision, that is, is blacked out or has mobile vision, intermittently, for 19·6 or say 20 per cent of the total time of vision.

As the periods of blackout and mobile vision undoubtedly show variations from person to person, just as in the case of their inter-blink periods (section *a* above), it is clear that the numerical data for any individual under given conditions should be separately determined in order to be able to evaluate the blackout indices with any precision. All we can do here is to confine ourselves to the data actually available in the literature, or individually determined. In Table 1 are given the data for the main types of subject (see sections *a*, *f* and *g*), for the rapidly blinking subject *X*, whose values I determined during reading and in animated conversation (see section *b*), and for myself in daylight and in the dark (see section *a*).

TABLE 1

Subject	Inter-blink period (sec.)	Black-out period (sec.)	Mobile vision period (sec.)	Black-out index (%)	Modified blackout index (%)
J-type (male)	2·8	0·3	0·25	11	20
„ (female)	*c.*4	0·3	0·25	7·5	14
Plateau type	*c.*12	0·3	0·25	2·5	4·6
Bimodal type	3·6	0·3	0·25	8·3	15
Symmetrical type	5·8	0·3	0·25	5·2	9·5
X (reading)	1·2	0·3	0·25	25	46
X (talking)	0·8	0·3	0·25	38	69
Self (daylight)	13·1	0·1	0·25	0·8	2·7
Self (dark)	13·6	0·1	0·25	0·7	2·6

Nots.—For trained observers, the shortest normal inter-blink period so far observed is 0·6 sec., and the longest 18 sec. (woman). The lower limit of the blackout period probably lies near 0·1 sec., whereas the upper limit may readily be as large as 0·5 sec., for some subjects screw their lids together during a blink.

The methods used in determining my own involuntary rate of blinking, blackout period, and mobile vision period will form the subject of a later communication. As no data on the period of mobile vision exist in the literature, the value entered in the appropriate column is that of my own eyes. From the data in the last two columns of the Table it will be seen that very wide individual variations in the blackout indices exist, and it is precisely this fact that is of great importance in physical measurements and in other spheres of human activity.

Classification of Error Types due to Blinking

Certain types of physical measurement must inevitably be in error by at least the amount indicated by the appropriate blackout index. Blackout and mobile vision errors will be present in all types of time observations, though for observers with a long inter-blink period they may be sufficiently small to be negligible, whereas for observers with a rapid rate of blinking the errors may be in excess of 50 per cent and can rarely be neglected.

In considering the subjective errors in physical measurements due to blinking, three main types call for comment, the first of these being by far the most important.

Type A: In subjective counting experiments, where the duration of the events counted is small compared with the blackout period, and especially when the succession of events is random, the results will be in error by at least the percentage indicated by the blackout index. In certain cases the period of mobile vision may still further increase the error. The counting of scintillations in radioactivity provides an excellent illustration of this type of error, for the duration of a scintillation (see Rutherford, ref. 5, p. 545) is of the order of 10^{-4} sec. (blackout period 0·3 sec.), and we shall return to it later.

Type B: When the duration of the events counted or observed is of an order comparable in magnitude with the blackout or modified blackout period, the effect of blinking is an essential part of the personal equation and must be allowed for. Moreover, the error involved will be greater the more rapid the rate of blinking of the observer.

Type C: As the duration of the events observed or the time of observation is progressively increased as compared with the blackout period, the errors due to blinking likewise become progressively less important. In other words, the uncertainty of observation resulting from blinking becomes less important as the time of observation is increased, and the effect of blinking on the personal equation is diminished. This is of importance in pendulum measurements or in observations on the fall of bodies either in the air or in a viscous medium (Stokes' law). It should also be borne in mind that in measurements by the method of coincidences, individual coincidences may easily remain unobserved should they occur during the blackout period of a blink.

In my long teaching experience I have frequently been puzzled by the fact that occasionally otherwise good students seem to be incapable of getting reasonably accurate results in experiments involving the measurement of times of the order of several seconds, and have been loath to put their misfortune down to carelessness. It seems probable that this defect may be connected with the process of blinking, and I can recall individual cases of high rates of blinking in such students. I have also noticed similar discrepancies in the measurement of Young's or Fresnel's (biprism) fringes, and a feasible explanation seems to be that such observers may have a high rate of blinking, so that their vision is blacked out or mobile during a relatively high percentage of the time of their measurements with a lateral traverse micrometer eyepiece, in addition to which occasional fringes may be skipped. In microscopy, too, observers with a high modified blackout index must find it difficult to be certain of the detailed finer structure of the specimen under examination.

In various branches of industry, also, there must be many processes and measurements in which the rate of blinking may be a handicap, and consideration of the process of blinking will surely have an important part to play in matters of vocational guidance. In particular, in mining, the irritation of the eyes produced by dust and the consequent raising of the rate of blinking (see section *c* above) may influence the safety factor, in addition to which miner's nystagmus with its accompanying mobile vision is, I understand, often associated with an enhanced rate of blinking.

Application in Radioactive Measurements

One of the most important constants in radioactivity is Z, the number of α-particles emitted per second by 1 gm. of radium and by 1 Curie of radon. Here the unit 1 Curie is used in its original sense, as the amount of radon in equilibrium with 1 gm. of radium. The value of Z has been determined on many occasions and by a variety of methods. In Table 2 a summary is given of the various methods that have been used in the determination, together with the final result for each[4]. In the words of Rutherford[4]: "Considering the difficulty of accurate measurement by some of the indirect methods, there is a fair accord". "There is no doubt that a direct determination of Z is beset with considerable difficulties, partly connected with the source of α-rays and partly with the efficiency of the electrical and scintillation methods of counting α-particles." "When we consider the care taken in the measurements, it is difficult to account for the divergence between the various values of Z, and particularly the low values in some determinations. One of the main difficulties in these experiments lies in the choice and preparation of a suitable source of α-rays which is free from all uncertainty and can be measured with precision."

TABLE 2

Method	Investigator	Date	Z
1. Electrical counting	(*a*) Rutherford and Geiger	1907	$3{\cdot}57\times10^{10}$
	(*b*) Hess and Lawson	1918	$3{\cdot}72\times10^{10}$
	(*c*) Geiger and Werner	1924	$3{\cdot}5\times10^{10}$
	(*d*) Ward, Williams and Cave	1929	$3{\cdot}66\times10^{10}$
2. Scintillation	Geiger and Werner	1924	$3{\cdot}40\times10^{10}$
3. Total charge	(*a*) Jedrzejowski	1927	$3{\cdot}50\times10^{10}$
	(*b*) Braddick and Cave	1928	$3{\cdot}68\times10^{10}$
4. Production of helium	(*a*) Boltwood and Rutherford	1911	$3{\cdot}50\times10^{10}$
	(*b*) Dewar	1910	$3{\cdot}69\times10^{10}$
5. Life of radium	Gleditsch	1919	$3{\cdot}55\times10^{10}$
6. Heating effect	(*a*) Rutherford and Robinson	1912	$3{\cdot}72\times10^{10}$
	(*b*) Watson and Henderson	1928	$3{\cdot}70\times10^{10}$
7. Volume of radon	Wertenstein	1928	$3{\cdot}7\times10^{10}$

It is of great interest to examine how the values obtained by the various subjective methods of determining Z may be influenced by the rate of blinking of the observer. Without exception all the methods, directly or indirectly, involve the measurement of time intervals, usually the duration of the experiment, and so the factor of blinking will enter in some small measure into the personal equation (Type *C*). But the error due to the period of blackout is likely to be disturbing only in the subjective measurements of methods 1 and 2. As Rutherford and Geiger used a long-period quadrant electrometer, their blackout error can be disregarded. This also holds for the method 1 (*d*), in which the particles were photographically recorded. We are thus left with methods 1 (*b*), 1 (*c*) and 2 in which the blackout and mobile vision errors may be of importance.

If the string electrometer used by Geiger and Werner in method 1 (*c*) was of the same type as was used by Rutherford and Geiger in their photographic recording of α-particles, its period of deflexion would be *c.* 0·01 and of return 0·02 sec., both of which times are small as compared with the period of blackout during blinking (0·3 sec.), so that the blackout error would be effective (Type *A*). Taking account of the blackout indices in Table 1, this would mean that the results might readily be low by several per cent. A short-period string electrometer thus has distinct disadvantages as compared with a long-period instrument in the subjective counting of particles, a point which has not been realized hitherto.

We may now consider Geiger and Werner's scintillation counting method (method 2). The question of the efficiency of scintillation counts has been the subject of much discussion[5], but the above workers devised an ingenious method which would appear to guarantee one hundred per cent efficiency. In this method the same area of the screen is viewed from opposite sides by the two observers, who record their counts on a drum. If N_1 and N_2 are their respective counts, and if C is the number of coincidences, then the true number of particles was shown to be $N = N_1N_2/C$. But also this method is not free from the error due to blinking, even if both observers have identical inter-blink periods and identical blackout periods, for, as already mentioned, the duration of a scintillation is *c.* 10^{-4} sec. and the period of blackout 0·3 sec. (Type *A*). Certain of their blinks would be sufficiently near to be considered practically simultaneous, especially when we remember that, after a relatively long inter-blink period, it often happens that several blinks follow in quick

succession, so that an appreciable number of particles would not be counted by either observer. Without numerical data concerning the acts of blinking of these two workers, no correction can be applied to their estimates of Z, but an error of ten per cent is well within the bounds of possibility, as will be seen by reference to the fifth column of Table 1.

In regard to scintillation counts, an abstract from some work by Chadwick[6] is suggestive: "When the scintillations appear on the screen at convenient intervals, it is possible for the two observers to compare their impressions of the intensity of the scintillations. It sometimes happens, particularly when dealing with the weaker scintillations, that a scintillation which appears bright to one observer is weak to the other." There seems little doubt that the weaker scintillation was seen by one of the observers during one of his periods of mobile vision (*c.* 0·01 and 0·25 sec.). Rutherford's remark (*loc. cit.*) "that the superior efficiency of an experienced observer appears to be due to greater concentration, to control of spontaneous movements of the eye, and to practice in using the ex-central portions of the retina, thereby avoiding the insensitive fovea-centralis" now requires to be supplemented by the statement—"and above all to a low value of the blackout index".

It remains to discuss method 1 (*b*) in Table 2, and here numerical data on the act of blinking are available, at any rate for one of the observers (see Table 1). These workers used a longer period Elster-Geitel string electrometer for their work. The string took just under 0·2 sec. to be deflected, and the entire displaced period[7] was greater than 1 sec. Since these times are appreciably greater than Lawson's blackout period (0·1 sec.), it is certain, even taking account of his period of mobile vision (0·25 sec.), that this observer saw at least two-thirds of a kick which occurred at the moment of a blink, so that the blackout error can be disregarded in his case. In regard to the second observer (Hess), nothing is known of his blackout period, but it is recalled that his inter-blink period was definitely shorter than that of Lawson, so that his blackout indices would be greater. A slight discrepancy in the estimates of Z by these two observers might therefore be expected, and was in fact found[8]. Thus in the final series of observations their mean corrected values of Z were:

Hess (114 determinations): $Z = 3{\cdot}68 \times 10^{10}$,
Lawson (154 determinations): $Z = 3{\cdot}75 \times 10^{10}$.

In all, about 80,000 particles were counted in these final determinations. The accuracy to be expected from this number of particles is thus of the same order as the guaranteed accuracy of secondary radium standards (0·5 per cent), which are used in the measurement of the sources. On the evidence available at the present time, therefore, there seems to be no valid reason for suggesting a change in the accepted value of $Z = 3{\cdot}70 \times 10^{10}$, for its true value is scarcely likely to be greater than $3{\cdot}75 \times 10^{10}$.

Further Applications of the Blackout Indices

It is of interest to note the effect of the act of blinking in other branches of human activity. In the realm of sport it is of great importance. When we consider that a motorist who has a rapid rate of blinking may be blacked out intermittently for about 40 per cent of his driving time, or 40 per cent of the distance travelled, we can surely discern in this a primary cause of proneness to accident. In fast games like tennis or badminton, the ball or the shuttlecock will certainly be lost to sight during the 0·3 sec. of the blackout due to blinking. For people with a high rate of blinking, bowls is a much more suitable form of recreation. In flying, too, the airman does not appear to have been aware hitherto of the effect of blinking on his efficiency, either in bombing a target or in fighter combat, for in the period of his blackout or mobile vision he may have travelled a distance of the order of one hundred yards. The effect will be greater still for the pilot of a jet fighter. The blackout indices are also of great importance in cricket, for if they are high, the batsman or wicket-keeper may lose sight of the ball between the wickets, the fielder may readily miss what seemed a sure catch, and the umpire may give a wrong decision. In boxing, too, a damaged eye stimulates blinking and thus an increase in the blackout index, whereas the time constants involved in the sensory and optical blinking reflexes may be all-important to the boxer. Also in photography it is to be expected that, on the average, a group of people will have approximately normal time constants of blinking, and in consequence, at any moment, a definite percentage of them equal to the normal black-out index (*c.* 10 per cent) will be in the act of blinking. This prediction is confirmed by the examination of group photographs. Thus in two recent topical photographs of groups of 43 and 18 persons respectively, three had closed and three half-closed eyes in the first, and in the second two had closed eyes.

In conclusion, it may be mentioned that all electrical valve counting circuits, by virtue of their time constants, must suffer from the disadvantage of blackout, but as the effects are calculable, they need not necessarily involve serious error in the count. Another electrical analogy is to be found in the time base of the cathode ray oscillograph, in which the fly-back time corresponds to the blackout period in blinking. In this case, also, the error involved can readily be determined.

[1] In particular, Ponder, E., and Kennedy, W. P., *Quart. J. Exper. Physiol.*, **18**, 89 (1928); Blount, W. P., *ibid.*, **18**, 111 (1928); Luckiesh, M., and Moss, F. K., *Illum. Eng.*, **35**, 19 (1940); Hall, A., *Brit. J. Ophthal.*, **29**, 445 (1945). General references: Duke-Elder, W. S., "Text-Book of Ophthalmology", **1**, 643–647 (Henry Kimpton, London, 1942); Glasser, Otto, "Medical Physics", 679–681 (Year Book Publishers, Inc., Chicago-Illinois, 1944).

[2] Miles, W. R., *Amer. J. Physiol.* (*Proc.*), **72**, 239 (1925).

[3] Macleod's "Physiology in Modern Medicine", 278 (1941).

[4] Taken from "Radiations from Radioactive Substances", by Rutherford, Chadwick and Ellis, 63 (Camb. Univ. Press, 1930).

[5] Rutherford, Chadwick and Ellis, 544–550. See also Geiger, H., and Werner, A., *Z. Phys.*, **21**, 187 (1924); Hess, V. F., and Lawson, R. W., *Phil. Mag.*, **48**, 200 (1924).

[6] Chadwick, J., *Phil. Mag.*, (7), **2**, 1056 (1926).

[7] Lawson, R. W., and Hess, V. F., *Wien. Ber.*, (IIa), **127**, 465 (1918).

[8] Hess, V. F., and Lawson, R. W., *Wien. Ber.*, (IIa), **127**, 456 (1918).

THE ECOLOGICAL APPROACH TO BOTANY

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THE last forty years have witnessed the growth and establishment of the *idea* of ecology. Twenty years ago it was possible for botanical professors to pronounce that they simply disbelieved in ecology, and it was a word of mystery to the general public. 1911 saw the publication of "Types of British Vegetation" by Prof. A. G. Tansley, and in 1913 the

British Ecological Society was founded, with its periodical *The Journal of Ecology*, to which in 1932 was added *The Journal of Animal Ecology*. In 1939 there appeared the monumental volume, "The British Islands and their Vegetation", by Prof. Tansley, which demonstrated by its advance upon "Types of British Vegetation" the tremendous extension of our ecological knowledge of British vegetation, and in 1942 Sir Edward Salisbury's book, "The Reproductive Capacity of Plants", which showed the progress of autecological investigation.

This expansion of ecology is due to the realization that natural history is not, after all, outside the scope of exact scientific inquiry, and it reflected that the eagerness of the old quest for knowledge of living organisms in the field had been coupled with new techniques and the methods of modern science. The consequence of this expansion is that ecology is now acknowledged by men of science and comprehended by most laymen.

Few, however, comprehend the power of the ecological idea, or how forceful a means it is proving to be in the expansion of knowledge, and in the advance of civilization. We have begun by the recognition that in schools and colleges the mere collection and identification of species and genera must, in educational interests, as well as scientific, give place to studies of the intimate biology of plants and animals, and of the relationships between them and their environment. The complexity and the scientific interest of the situation thus disclosed have affected scientific research in the widest fields: marine biology, with its studies of herring shoals, whale fishing, sealing, and seaweed survey; ornithology, with its intensive and extensive census and migration studies, and starling, rook, wood-pigeon, and sea-bird inquiries; entomology, with its immense fields of applied science, and locust, tsetse, wireworm and aphid investigations; vertebrate ecology of fur-bearing animals and lemming, rat, grey squirrel and coypu; forestry, with its problems of exploiting and equally of maintaining natural forest; all these and many other sciences bear witness to the penetration of the ecological idea into appropriate scientific fields, and of its fruitfulness therein.

It owes its success simply to the timeliness of the reaction against premature simplification of biological interpretation, and premature syntheses from basic generalizations. It is a study demanding constant return to the primary data, which are the observations in the field, and constant emphasis on the reaction of the organism as a whole in its environment.

The value of this approach is apparent in the quality and bulk of the results achieved, and in a demand for trained ecological research workers which far outstrips supply. Wherever biological material is involved, be it rubber, teak, penicillin, slugs, lettuces, lice, cotton, or cat-fish, there comes the need for ecological inquiry, and naturally this is most realized where great natural resources in unexploited lands are being surveyed for their potentialities. Let there be no question: only an ecological approach will now serve us in these regions. Gone are the days of the old German dogma that forests should be grown like crops of potatoes, and rapidly vanishing are the prospects for the heedless garnering of the earth's natural products. The immense destructiveness of modern exploitation has been brought home by the ghastliness of soil erosion phenomena in all parts of the world; but avoidance of such ills inevitably depends upon adequate ecological understanding of the systems of animal and plant life, soil, and climate which are involved.

There was a day when T. H. Huxley wrote and spoke with powerful effect against the neglect of biological teaching, and of biological knowledge, on the substantial ground that man himself is an animal. It needs little effort to extend this thesis, to-day so readily approved, to the understanding that we humans are not distinct from the biome; but that human communities, be they what they may, *all* form an inseparable part of the larger environment. There is no break in kind between the relationships of the great eco-systems of plant and animal communities, and those which include fewer or more human beings: the minor role of the sparse bushmen in their own forest environment grades into our own within a complex mechanical civilization. Since still the human agents remain animal in nature, sustain themselves within communities, and subsist on biological materials, they are no less part of the eco-system than were their ancestors. It is, indeed, appropriate and needful that to the complexity of the world's social problems there should increasingly be brought to bear an ecological and realistic interpretation. This is not to demand here and now the setting up of commissions, institutes or departments of human ecology, but to point out that such problems will be solved only by a generation which has been trained to adopt a sufficiently broad ecological outlook.

It is in our favour that the youth of Great Britain, more than at any time before, receives encouragement to develop such an outlook. Schools (encouraged by syllabuses of progressive examination bodies) devote increasing time to it, and are strongly assisted by the admirable organisation of the Council for the Promotion of Field Studies.

It has never escaped the attention of Prof. Tansley, who for so long has been the inspiration of British ecology, that the standard of school and university teaching in ecology depends upon the quality of the text-books available, and he has added to the debt which the science (and the country) owes him by sponsoring the timely issue of three ecological text-books, which will shape all elementary ecological study in Great Britain for some years to come. These are, first, "An Introduction to Plant Ecology"[1], written by himself, upon the basis of his well-known "Practical Plant Ecology". This keeps the general character of the older book, but also includes chapters on the modern theory of communities, succession, and life-form. The soundly balanced philosophical outlook and the clarity of style which Prof. Tansley commands would alone suffice to justify the book, which, in fact, is indispensable to all taking up the study of ecology, be they teachers or students, and at school or university level.

One of the pioneers to develop school ecological studies was E. Price Evans, who is also known for his work upon the ecology of Cader Idris. He and Prof. Tansley have combined in the writing of "Plant Ecology and the School"[2], a slenderer and more elementary work than that just mentioned, and aimed to make apparent by actual instances exactly how ecology can be practised in schools. This work rightly stresses the *integrative* influence of such ecological studies, and recommends their incorporation in studies of regional geography, and in general science courses. The authors properly observe that plant ecology is not so much a 'subject'

as a method of approach to the study of plants, and this holds equally, of course, for all fields of ecology.

The last book of the trio under review, "Practical Plant Ecology", is by Prof. R. C. McLean and Dr. Ivimey Cook[3]: it gives an account of the field methods and field apparatus which have been found useful in the botanical courses of the University of Cardiff. Its matter-of-fact descriptions of apparatus and technique come down to the level of average students, and will give the means to many hitherto uninstructed folk of gratifying their desire to apply precise measurement to botanical field study. The many examples of records made by students indicate the enthusiasm which the authors have engendered in their classes. There is, of course, a danger that students may record data of temperature, light, or pH, without any comprehension of applicability to the ecological situation being examined; but this can be guarded against by good teaching, and by conjoint use of the "Introduction to Plant Ecology". It is the commencement of careful record and measurement that is for the moment of prime importance, and this book will go far to ensure it. Messrs. Allen and Unwin are to be congratulated upon providing schools and universities with three excellent books, so satisfactorily supplementing each other; it now remains to meet a similar need in the realm of animal ecology, and to show the way to teach the study of the biome, with its complex integration of both plant and animal life.

[1] Introduction to Plant Ecology: a Guide for Beginners in the Study of Plant Communities. By A. G. Tansley. Entirely revised and enlarged second edition of "Practical Plant Ecology". Pp. 260. (London: George Allen and Unwin, Ltd., 1946.) 8s. 6d. net.

[2] Plant Ecology and the School. By A. G. Tansley and E. Price Evans. Pp. 98. (London: George Allen and Unwin, Ltd., 1946.) 6s. net.

[3] Practical Field Ecology: a Guide for the Botany Departments of Universities, Colleges and Schools. By Dr. R. C. McLean and Dr. W. R. Ivimey Cook. Pp. 208. (London: Allen and Unwin, Ltd., 1946.) 9s. net.

SCIENCE AND U.N.E.S.C.O.

MEETING AT MEXICO CITY

IN this article we are concerned mainly with the present results from the successful drive to put the 'S' into 'U.N.E.C.O.'. The presence of some thirty scientific men from the thirty-three countries represented at the second general conference of the United Nations Educational, Scientific and Cultural Organisation, held in Mexico City last November, was an earnest that the 'S' had come to stay; the careful preparations for the programme made by Dr. Joseph Needham and the staff of the Natural Sciences Division and the clear statements made by the representatives of the scientific working party in the plenary sessions account largely for the successful piloting of the various scientific projects past budgetary and other obstacles.

To one accustomed to the atmosphere of international gatherings of scientific men, a first impression of a meeting of the United Nations Educational, Scientific and Cultural Organisation is that, whereas science is truly international in outlook and has learnt to work along international lines, culture is essentially national or racial in outlook and is only just beginning, save on the more mechanical side of museums and libraries, to walk easily along the international path. While the eloquent protest of Sir Sarvepalli Radhakrishnan that the culture of the East is insufficiently represented on the staff of the Organisation was received with sympathy and applause, speeches which sounded as though they might have been delivered at Lake Success were seen to lie clearly outside the sphere of the Organisation's interests and activities. The temper of the meeting clearly indicated a desire for as complete co-operation as possible: political differences were barred, though in some cases national or racial differences were accepted as playing an inevitable part under present conditions.

The programme of many varied schemes for 1948 put forward in advance of the meeting by the Executive Board called for an all-over budget of 8,500,000 dollars. As a first step, this was reduced by the full meeting of delegates by 800,000 dollars, so that when the various sectional working parties met to discuss their programmes in detail, they knew approximately the size of the grant that they were likely to receive and they could modify the proposed plans accordingly. The chairman of the working party of the Natural Sciences Division was Dr. H. J. Bhabha. The programme ultimately adopted by this party and accepted by the plenary session included the following items:

(1) *Grants in Aid to Non-governmental Organisations* (for example, the International Scientific Unions and other bodies of an international character), to meet travelling expenses, publication charges, etc.; a total of 240,000 dollars was approved.

(2) *The Hylean Amazon Scheme.* The Organisation is generously supporting in its initial stages the proposal to found an international scientific institute at Belem to study the problems of the great forest zones and the basins drained by the valley of the Amazon. Physical geography, including soil science, biology, anthropology, agriculture and nutrition all provide special problems to be considered. Brazil, as the country most concerned, backs the scheme strongly. It is being supported by the other countries involved in the area—Bolivia, Colombia, Ecuador, Peru, Venezuela and the British, French and Dutch Guianas—also by the United States and at its own request by India, as a country much interested in tropical problems. The Organisation is making a grant of 100,000 dollars in 1948 for initial surveys. Of this sum, 50,000 dollars comes from the money for the Field Science Co-operation Office for Latin America; Mr. E. J. Corner will be in charge of the initial organisation.

(3) *Field Science Co-operation Office.* In addition to the Office for Latin America, which is to be assigned for the present to the Hylean Amazon, there already exist two field offices which act as links between the main centres of learning and research and countries remote from such centres. One is at Nanking, serving Far East Asia and the Philippines; the other is at Cairo for the Middle East. The officers in charge are Mr. J. Smid, of Czechoslovakia, and Dr. L. T. Thuriaux, of Belgium, respectively. An additional office for India was agreed to by the conference.

(4) *Popularization of Science and of its Social Implications.* Following upon two meetings of experts called together in Paris and in New York during October last, the United Nations Educational, Scientific and Cultural Organisation decided to stimulate research and surveys in this field by fellowships, by co-operation with existing bodies working on the subject and by the preparation and circulation of reports.

The Division of Natural Sciences will also play a part in a number of schemes supported by the Organisation, but having a wide range and affecting other branches of knowledge. These include methods of dealing with rehabilitation in war-devastated countries, exchange of personnel between countries, passage of books across frontiers, documentation, use of mass media for the spread of information, etc.; as in the case of libraries and museums, men of science are directly concerned in these projects, but only as part of a much wider group of interested people. The same applies to certain aspects of education, which provide the main body of the activities of the Organisation, and call for a separate report in itself.

With regard to the future position of science in the United Nations Educational, Scientific and Cultural Organisation, one fact must be borne in mind. The natural sciences were well organised at the start along international lines, while certain other subjects such as the humanities and the social sciences were not. As they fall into line—and the Division for Philosophy and the Humanities has already asked the Organisation to organise a central council along the lines of the International Council of Scientific Unions—they will find useful ways of spending money and will make their appeal to the Organisation for grants. Unless the income of the Organisation rises with its increased opportunities and responsibilities, the grants to science will be maintained at their present level only with difficulty.

In closing this account, tribute must be paid to the Mexican Government for its gracious welcome and generous hospitality; the Lebanese Government has been set a hard task for this year's conference at Beirut. This will be the last conference at which Dr. Julian Huxley will hold office as director-general. Dr. Needham retires from the post of head of the Natural Sciences Division this spring. Both of them have placed the scientific men of the world under a debt of obligation by the way they have initiated the scientific section of an organisation which has great possibilities for the future of the civilized world.

F. J. M. S.

THE EARTH'S SURFACE MAGNETIC FIELD AND ITS SECULAR CHANGE

By Prof. SYDNEY CHAPMAN, F.R.S.

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington renders a signal service to science by the publication of the important volume entitled "Description of the Earth's Main Magnetic Field and its Secular Change, 1905–1945"[1]. In a sense this represents the attainment (for the time) of one primary objective urged by the first director of the Department, the late L. A. Bauer, upon Andrew Carnegie, in the negotiations which led in 1904 to the institution of the Department. The volume has been prepared almost entirely under the control of the second director, J. A. Fleming, who from early days was Bauer's right-hand man in the development of the Department. The third director is to be congratulated on being able to issue so great a contribution to the science for the furtherance of which his Department was founded.

Bauer set himself with immense zeal to the task of promoting a world magnetic survey more complete than any previously attempted. As most of the earth's surface is water, the chief need was to survey the oceans. Bauer acquired a sailing vessel, the *Galilee*, for his Department, and adapted it (adding auxiliary engines) for magnetic survey work, on which it made three cruises. A non-magnetic vessel, the *Carnegie*, was then specially constructed, which made seven great survey cruises before it was overtaken by the disaster of destruction by fire in the harbour of Apia, Samoa, in 1929. These cruises form the main basis of our knowledge of the earth's surface magnetic field to-day, though supplemented by information provided by the land magnetic surveys undertaken by the principal civilized States in their own or dependent territories, and by the work of many polar and other expeditions.

Since 1929 our knowledge of the earth's magnetism has been slowly worsening. The outbreak of war halted the completion and equipment of the Royal Research Ship *Research*, a non-magnetic vessel built by the British Admiralty to resume the ocean magnetic survey work so well executed by the *Carnegie* during two decades. The fate of the *Research* is at present in doubt, but it may be hoped that the ship will soon begin her work and help to renew our current knowledge of the earth's ever-changing magnetic state.

Although Bauer intended to make a thorough theoretical study of the magnetic data obtained by his survey ships and by the land magnetic expeditions he organised or aided, along with all other available data, he actually made only slight progress in this work. But with generous wisdom he made his data quickly available for use in the construction of magnetic charts by the principal national agencies responsible for producing such charts. In particular, the early work of the *Galilee* and *Carnegie* formed the basis of the Admiralty charts when their preparation was transferred in 1917 to the Royal Observatory, Greenwich.

The supervision of this work by the then Astronomer Royal, the late Sir Frank Dyson, enhanced his interest in geomagnetism and led him, with H. Furner, to make an excellent spherical harmonic analysis of the earth's field for the epoch 1922—the only thorough analysis made during a considerable period extending before and after 1922.

The subsequent further accumulation of magnetic data enhanced the need for further study of the world-wide distribution and secular change of the field. A valuable beginning of this work was made in 1930 by H. W. Fisk (of the Department of Terrestrial Magnetism, Carnegie Institution), by his isoporic charts showing for each magnetic element the lines (isopors) of equal rate of secular change. The Department's plans for a more comprehensive treatment of this century's store of magnetic data first began to mature rapidly when, during the War, the work became the subject of a Government contract under the United States Naval Department. It was entrusted to a team of members of the staff of the Department of Terrestrial Magnetism, under the able leadership of E. H. Vestine, and has been executed thoroughly and successfully. The volume now under notice is the first fruits, and is to be followed by others giving a new spherical harmonic analysis of the field, and other developments.

The main contents of the volume indicate (i) the state of the earth's surface magnetic field for the epoch 1945·0, and (ii) the rate of change of the field at each of the four epochs 1912·5, 1922·5, 1932·5 and 1942·5. The field can be specified at any point by

three elements, such as D the magnetic declination, H the horizontal magnetic intensity, and Z the vertical intensity; but other specifications are equally valid, involving one or more of these three elements, together with a choice from the further four elements, X and Y the north and east horizontal components, F the total intensity, and I the magnetic inclination or dip. All these elements are represented in this volume (though not all to an equal extent) by charts, tables and graphs. They are based on more than 100,000 individual observations, relating to nearly 10,000 stations for D and 5,000 stations for the other elements.

There are sixty-three isomagnetic charts for 1945·0, namely, fifteen large-scale sectional diagrams on Mercator's projection, with two polar charts (northern and southern) for the elements D, H and Z, and three charts (one Mercator, covering the middle belt between latitudes 73° S. and 84° N., and two polar charts, north and south) for each of the other four elements.

The isoporic charts number eighty-four, namely, three each (two polar and one for the belt 73° S. to 84° W.) for each of the seven elements for each of the four epochs.

Only the middle-belt isomagnetic charts (for X, Y, F and I) and the middle-belt isoporic charts show the background of geographical outlines.

The unusually large scale of the isomagnetic 1945·0 charts for D, H and Z enables smaller anomalies to be shown than is usual on magnetic maps, at least over the oceans. But Vestine explicitly disavows any claim that the charts represent an accurate description of the field, because there are many regions which have never been magnetically surveyed, across which uncertain interpolations had to be made.

Values for 1945·0 of each of the seven elements, scaled from the charts at 5° intervals of latitude and longitude, and of their rates of secular change at each of the four epochs, scaled from the isoporic charts at 10° intervals of latitude and longitude, are given in tables, part of which are separately published[2].

The volume also includes 214 graphs showing the time variation of each element (separately for D, H and I, and in combination for X, Y, Z and F) for a hundred magnetic observatories, and a sample of eleven repeat stations (out of about two thousand for which such graphs were prepared in the course of the work). The positions of the observatories and of the survey and repeat stations are shown on supplementary charts.

This volume is unique in geomagnetic literature not only for the extent of the underlying data and the fullness of the reduction and representation of the data; it is the first to describe at all adequately the nature of the processes of reduction and representation, with examples of the actual working sheets of computations for a typical observing station. A useful improvement in the work has also been made by rendering the X and Y charts, and the D and H charts (both isomagnetic and isoporic), mutually consistent on the hypothesis of negligible electric currents crossing the earth's surface; and also by the use of simple analytic considerations on the form of the isomagnetic and isoporic lines near dip poles.

The volume is a worthy embodiment and memorial of the first quarter-century of the observing work of the Department of Terrestrial Magnetism; may this work be emulated and surpassed during the remainder of this twentieth century. The development of methods of aerial magnetic survey seems to hold much promise for the future, though meanwhile well-tried methods should not be neglected.

[1] Carnegie Institution of Washington: Department of Terrestrial Magnetism. Publication 578: Description of the Earth's Main Magnetic Field and its Secular Change, 1905–1945. By E. H. Vestine, Lucile Laporte, Caroline Cooper, Isabelle Lange and W. C. Hendrix. Pp. v+532. (Washington, D.C.: Carnegie Institution, 1947.) 2.50 dollars.

[2] Carnegie Institution of Washington: Department of Terrestrial Magnetism. Final Values of Elements of the Geomagnetic Field at 5-Degree Intervals of Latitude and Longitude, Epoch 1945. By L. Laporte, C. Cooper, I. Lange, W. C. Hendrix and E. H. Vestine. Pp. 73. (Washington, D.C.: Carnegie Institution, 1946.) n.p.

OBITUARY

Prof. Ludwig Becker

Prof. Ludwig Wilhelm Emil Ernst Becker, for forty-two years occupant of the regius chair of astronomy in the University of Glasgow, died at Merano in Italy on November 11, 1947. Becker was born at Wesel in Germany in 1860 and educated at the University of Bonn where, in due course, he took his Ph.D. degree. In 1885, after two years as an assistant in the Berlin Observatory, he was recommended to the Earl of Crawford and Balcarres, who owned a large private observatory at Dunecht, near Aberdeen, in professional charge, at the time, of Dr. R. Copeland. In the autumn of 1888 Lord Crawford presented the whole of his magnificent equipment, including his astronomical library of 15,000 volumes, to the Lords Commissioners of the Treasury for a new Royal Observatory. A site on Blackford Hill in Edinburgh was selected in 1889; Becker was included on the staff, with Copeland as Astronomer Royal. Four years later, Becker was appointed to the regius professorship of astronomy at Glasgow, occupying the chair until his retirement in 1935. The University Observatory half a century ago was well equipped for contemporary needs, and in his earlier years he extended considerably its instrumental resources.

Becker was an inspiring teacher. His 'honours-lectures' were mainly on celestial mechanics, of which he was a master. His scientific work covered a wide variety of subjects, of which the following may be mentioned: his investigation on the distribution of blue-violet light in the solar corona at the eclipse of August 30, 1905, in Tunisia; a long and careful investigation on the constant of aberration undertaken with the Glasgow transit circle; a capture-hypothesis relating to binary stars, in which he showed how such a system could capture a third star, losing in the process one of its own components, and how the hypothesis could account for the high eccentricities of binary star orbits (it may be added that this idea of capture has recently been adopted by Lyttleton in his earlier attempts to explain the formation of the planetary system); descriptions of various instrumental improvements such as a motor-micrometer for the transit circle and a new 'artificial horizon' for sextants.

Although Becker had become a naturalized British citizen before his appointment to Glasgow, this fact failed to save him from embarrassment and unmerited suspicion during the First World War; local public opinion forced his temporary retirement to Aviemore in the Highlands, where he lived in seclusion until the end of hostilities. Becker was one of the gentlest of men, modest and retiring in disposition and, whatever the outside world thought, respected and esteemed by his students both for his learning and his kindly qualities. W. M. Smart

NEWS and VIEWS

Scientific Research and Development in Northern Ireland

In accordance with its policy of encouraging the increased application of the results of scientific and industrial research by industry in Northern Ireland, the Ministry of Commerce has formed a Council of Scientific Research and Development. The work of this Council, which will be closely linked with that of the Directorate of Scientific Development of the Ministry of Commerce, will be carried out under the following terms of reference: (1) to advise the Ministry of Commerce on all scientific questions connected with the utilization and development of the natural resources of Northern Ireland; (2) to promote the increased application by industry in Northern Ireland of the latest discoveries and developments in the fields of pure and applied science with the object of improving present industrial methods and processes, creating new industries and expanding existing ones; (3) to arrange, through the Director of Scientific Development, for such investigations and research work as the Council may consider desirable in the best interests of Northern Ireland; (4) to promote the wider dissemination of scientific knowledge throughout Northern Ireland.

The composition of the Council is as follows: Sir David Lindsay Keir, president and vice-chancellor of the Queen's University, Belfast (*chairman*); Mr. D. H. Alexander, Belfast College of Technology; Prof. R. G. Baskett, professor of agricultural chemistry, Queen's University; Mr. O. F. Brown, Department of Scientific and Industrial Research; Mr. H. Bryson (Spence Bryson and Co., Ltd.); Prof. J. K. Charlesworth, professor of geology, Queen's University; Mr. M. Eitel (Stevenson and Son, Ltd.); Prof. K. G. E. Emeléus, professor of experimental physics, Queen's University; Prof. D. C. Harrison, professor of biochemistry, Queen's University; Mr. A. J. Howard, Ministry of Commerce; Prof. K. S. Isles, professor of commerce, Queen's University; Mr. B. M. Cance (Kirkpatrick Bros., Ltd.); Prof. A. H. Naylor, professor of civil engineering, Queen's University; Mr. D. Rebbeck (Harland and Wolff, Ltd.); Dr. A. J. Turner, Linen Industry Research Association; Mr. R. C. Wilson (Newforge, Ltd.); Mr. D. E. Wiseman (Short and Harland, Ltd.); and Prof. A. R. Ubbelohde, professor of chemistry, Queen's University. All inquiries in connexion with the activities of the Council should be addressed to the Director of Scientific Development, Ministry of Commerce, 20 College Gardens, Belfast.

Generation of Electricity from Wind Power

The work of the Section on Rural Electrification of the British Electrical and Allied Industries Research Association has already included research on the small-scale generation of electricity, principally by wind power. Recent shortages of power and fuel have aroused interest in the possibility of utilizing wind power on a large scale for the generation of electricity in Great Britain. Following earlier discussions with the relevant Ministries and other interested parties, the Association has established a new Section on Power Generation with the following terms of reference: "To study the technical and economic problem of large-scale aerodynamic generation in Great Britain; including the collection of all available information and evidence, the principles of the selection of sites and the wind energy derivable therefrom, the co-ordination of wind-driven generators with supply systems, the essential design features of wind-driven generators and the design problems which remain to be solved". The chairman of the new Sectional Committee is to be Mr. T. G. N. Haldane of Messrs. Merz and McLellan. The Committee is expected to comprise representatives from electricity supply, electrical manufacturers, consulting engineers, the Department of Scientific and Industrial Research and the Lord President's Office, the Meteorological Office, the Ministry of Fuel and Power and the Ministry of Supply. Representatives of the aircraft industry will also be invited, as may seem desirable. The research officer for the new Section will be Mr. E. W. Golding, who is in charge of the Association's work on rural electrification and its field station at Shinfield Green, near Reading.

Medical Research in South Africa

The annual report of the South African Institute for Medical Research for 1946 records activities so various that a short note cannot mention them all. Mr. G. H. Beatty, chairman of the Board of Management since 1939, retired in 1946 and was succeeded by Mr. E. H. A. Lawrence. The Institute's close co-operation with the University of the Witwatersrand continues. Increased attention is being given to the problem of the universal donor of blood for transfusion, and studies of the Rhesus factors have been continued. Work on the vole tuberculosis bacillus has included a continuation of immunization experiments previously carried out to include *Cercopithecus* monkeys and rodents. Two species of gerbils have proved equally susceptible to *Mycobacterium tuberculosis* and the vole bacillus, so that they cannot be used for cross-immunization work. Work on leprosy included treatment of lepers with 'Promin', a new sulphone; but blood examinations showed no significant change over a period of four months. Considerable work has been done on diphtheria, dysentery, tetanus, gas gangrene, relapsing fever, typhus fever and other diseases; a plague-like epizootic occurring among gerbils in the Johannesburg area was, after investigation, ascribed to *Listeria monocytogenes*, and further study of this organism, which influences the wild rodent population and is also present in domestic rats, gave interesting results which are outlined in this report. Entomologists will be interested in the list of vectors of yellow fever, which records thirty-four species of mosquito new to northern Bechuanaland, also in the work on the physiology of *Cimex lectularius* and the larvæ of *Aedes ægypti*. Standard bed bugs are being reared for the biological assay of insecticides. Work has also been done on nutrition, venoms and antivenenes, and allergy, and a considerable volume of routine work accomplished.

Evolution: An International Journal of Organic Evolution

Workers in various fields such as taxonomy palæontology, cytology, genetics, comparative anatomy, etc., besides the problems inherent in their own fields, often have to take into account and make contribution to the wider field of thought covered by the term 'evolution'. The interest in this major subject has increased noticeably in recent years, and it was with the object of facilitating this modern synthesis that a Society for the Study of Evolution

was founded in the United States in March 1946. A grant from the American Philosophical Society has enabled this new society to launch a quarterly publication termed *Evolution: an International Journal of Organic Evolution*, and thus supply a noticeable want. The first number was issued in July 1947 and it is edited by Dr. Ernst Mayr, of the American Museum of Natural History, assisted by associate editors which include representatives of Great Britain, France, and the U.S.S.R. The journal is of convenient size, 25 cm. × 17 cm., well printed on paper that allows the use of half-tone blocks without undue loss in reproduction, and contains 112 pages. In general, contributions are limited to twenty pages, but shorter "Notes and Comments" are also published. They are accepted from any field of biology so long as they have a bearing upon evolution. The contributions in the first number include several papers on *Drosophila*, cytology, Hawaian birds, adaptive evolution in sticklebacks, hybrids in oak-tree populations and evolutionary rates in hypsodonty in horses and beavers. The subscription-rate for the volume is 6.00 dollars, or membership of the Society, which includes the journal, is 5.00 dollars, and the business manager is Mr. K. P. Schmidt, Chicago Natural History Museum, Chicago 5, Ill., U.S.A.

Disposal of Effluents from Harwell

THOROUGH precautions are being taken by the Ministry of Supply to ensure that the Thames water used at the Atomic Energy Research Establishment at Harwell is returned to the river free from risk of harmful radioactivity. These precautions are being adopted after close consultation between Harwell experts and experts of the Ministry of Health, the Metropolitan Water Board and the Thames Conservancy, and on the advice of the Medical Research Council's Research Committee on the Medical and Biological Applications of Nuclear Physics. A certain amount of radioactivity in drinking water can be tolerated by human beings, and the tolerances laid down by the Medical Research Council for the Thames water are such that the medical and biological effects due to the consumption of water during the life-span of human beings would be for all practical purposes negligible. Roughly one million gallons of water a day will be involved. The greater part will be used for the cooling of plant and ordinary domestic requirements at the Establishment. The remainder of the water will be used for research processes, some of them radioactive, and a carefully controlled separate water system will be installed to deal with it. The most highly active portion will be segregated and will not be returned to the river. The remainder will be delivered to storage tanks where it will be tested by medical officers for compliance with the agreed tolerances, treated for chemical impurities and then mixed with the domestic waste water before being discharged into the Thames at Sutton Courtenay.

The system of treatment and examination has been designed so that several operations have to be carried out before the water actually passes into the six-mile long discharge pipe. Moreover, a new weir is being constructed at the point of discharge into the Thames, and the Harwell water will thus be turbulently mixed with much greater quantities of river water immediately it joins the main stream. These safeguards have received the approval of the Ministry of Health. The Thames Conservancy has decided to raise no objection to the proposals, so far as their interests are concerned, in view of the safeguards agreed to be adopted and having regard to the assurances they have received from the Ministries concerned. By arrangement with the Ministry of Supply, the Thames Conservancy will be able to have samples taken at regular intervals for test purposes; the Ministry of Supply is providing facilities for testing such samples at a small riverside laboratory where Ministry of Supply scientific workers will themselves make sample tests and assist the Thames Conservancy.

Grants for Veterinary Education

THE University Grants Committee, the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland have appointed an Inter-Departmental Committee to inquire into the financial needs of veterinary education in Great Britain and to make recommendations to the University Grants Committee, in respect of universities, and to the appropriate Agricultural Minister, in respect of other educational institutions, as to the application of any moneys provided by Parliament towards meeting these needs. The Committee is constituted as follows: Dr. A. E. Trueman (*chairman*), deputy chairman of the University Grants Committee; T. Dalling, director of the Veterinary Laboratories of the Ministry of Agriculture and Fisheries; H. W. Dawes, president of the Royal College of Veterinary Surgeons; Sir John Fryer, secretary of the Agricultural Research Council; Dr. Thomas Loveday, chairman of the Joint Advisory Committee on Agricultural Education; Prof. G. W. Pickering, professor of medicine in the University of London; J. N. Ritchie, deputy chief veterinary officer, Ministry of Agriculture and Fisheries; W. L. Weipers, member of the boards of governors of the Royal (Dick) Veterinary College, Edinburgh, and of the Glasgow Veterinary College. The secretary to the Committee is Mr. E. Earnshaw Smith, of the University Grants Committee, 38 Belgrave Square, London, S.W.1. The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland will each appoint an assessor to the Committee.

French Conference on Ageing of Population

THE French National Union for Prevention of Depopulation and the French National Demographic Institute are organising a three-day conference on scientific research on ageing in the population of France, to be held in Paris during April 22–24. The programme of the conference is comprehensive: it includes sections of (1) demography, (2) economic and (3) social aspects of the problem, (4) physiology, psychology and pathology of old age, (5) organisation of work and occupation for old people, (6) rejuvenation of population. The conference will not be an international one; all reports will be by French workers, and discussions will be in French. Although only a few foreign specialists in demography, social and economic sciences, and gerontology have been invited, specialists in these subjects can attend the conference without a special invitation and, provided they will speak in French, take part in discussions. The president of the Organisation Committee is M. F. Boverat, 217 rue de Faubourg St. Honoré, Paris, 8e.

International Conference on Large Electric Systems

AN International Conference on Large Electric Systems (C.I.G.R.E.) will be held in Paris during June 24–July 3. Matters relating to the British

delegation to the Conference are being dealt with by the British National Committee under the chairmanship of Mr. P. V. Hunter, at the offices of the British Electrical and Allied Industries Research Association. The official languages of the Conference will be English and French. Owing to the difficulties of accommodation, etc., intending delegates are requested to communicate with Mr. R. A. McMahon, Secretary, British National Committee, C.I.G.R.E., "Thorncroft Manor", Dorking Road, Leatherhead, as early as possible.

British Council Conference Grants

THE British Council has for some time had a small fund from which grants have been made in exceptional cases to permit foreign men of science (including agriculturists, engineers and medical men) to attend national or international conferences or meetings held in the United Kingdom. The principal grounds upon which such grants have been made are: (*a*) that the application has been received from the body convening the conference or meeting; (*b*) that the Science Committee of the British Council has supported the application; (*c*) that the foreign visitor would be unable to attend without assistance. The grants cover subsistence or part-subsistence in the United Kingdom during the period of the conference or meeting. Fares to and from the United Kingdom are not included. No grants are made in respect of secretarial or other organising expenses, or for entertainment of delegates or hire of premises. Conveners of conferences or meetings to be held in the fiscal year 1948–49 are advised that it is necessary that applications for assistance to foreign visitors should be received not later than a fortnight from the publication of this notice. All applications will be considered together, and conveners will be notified of the results by the end of February. It is improbable that more than a small proportion of applications can be met from the fund. Applications with full particulars (including reasons why financial support is considered necessary) should be addressed to the Administrator, Science Group, British Council, 3 Hanover Street, London, W.1.

Coats Fellowships at Glasgow

MESSRS. J. AND P. COATS, LTD., have provided funds for a research fellowship in chemistry or physics (excluding nuclear physics), tenable for two years, of the annual value of £300 and a supplement of £50 to cover research expenses. The Coats Fellowship will normally be awarded to a candidate with at least one year's experience in research work. It will be held in the University of Glasgow, but is open to graduates in science of any British university. The selection board will consist of the professors in the Departments of Chemistry and Natural Philosophy. A Coats Fellowship, similar in general conditions to that instituted at the University of Glasgow, is being offered to the Royal Technical College, Glasgow.

Biography of Sir Joseph Barcroft

PROF. K. J. FRANKLIN, Department of Physiology, Medical College of St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1, has been entrusted by Lady Barcroft and Prof. Henry Barcroft with the preparation of a biography of the late Sir Joseph Barcroft. He accordingly invites the co-operation of Sir Joseph's numerous friends and colleagues; he does not ask, at this stage, for specific information on particular aspects of Sir Joseph's life or work, but for general comments, such as mode of treatment, anecdotes, etc. Full acknowledgment will be made in any consequent publication, and it is assumed by Prof. Franklin that, should he be prevented from writing the biography, the material may be passed on to an alternative author chosen by Lady Barcroft and her son. Communications should be sent to Prof. Franklin at the address above by April 30 next.

The Night Sky in February

NEW moon occurs on Feb. 10d. 03h. 02m., U.T., and full moon on Feb. 24d. 17h. 16m. The following conjunctions with the moon take place: Feb. 5d. 06h., Jupiter 3° N.; Feb. 11d. 06h., Mercury 8° N.; Feb. 13d. 12h., Venus 3° N.; Feb. 23d. 13h., Saturn 4° S.; Feb. 24d. 02h., Mars 0·6° S. During the first part of the month, Mercury is an evening star, setting at 18h. 20m. and 17h. 58m. on Feb. 1 and 14 respectively, and is in inferior conjunction on Feb. 20. At the end of the month it rises about three-quarters of an hour before the sun but will not be an easy object to observe. Venus, stellar magnitude about − 3·5, is conspicuous in the western sky and sets at 20h., 20h. 40m. and 21h. 30m. at the beginning, middle and end of the month respectively —several hours after sunset. Mars, in the constellation of Leo, rises in the early evening hours and can be seen throughout the night. Jupiter does not rise until the early morning hours—4h. 47m. and 3h. 18m. on Feb. 1 and 29 respectively; but as the planet does not attain an altitude greater than 16° in the latitude of Greenwich, it is not very favourably placed for observation. Saturn, in the constellation of Leo, rises in the early evening hours and can be seen throughout most of the night. The planet is in opposition on Feb. 9. Occultations of stars brighter than magnitude 6 are as follows: Feb. 18d. 18h. 37·7m., υ Taur. (*D*); Feb. 18d. 19h. 05.3m., 72 Taur. (*D*); Feb. 20d. 00h. 49·9m., 125 Taur. (*D*); Feb. 26d. 23h. 02·6m., γ Virg. *m* (*D*); Feb. 26d. 23h. 29·7m., γ Virg. *m* (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude and longitude of Greenwich are assumed. In addition to these occultations of stars, Mars is occulted by the moon on Feb. 24d. 01h. 58·9m., reappearing at 02h. 45·4m.

Announcements

SIR EDWARD MELLANBY will deliver the Sir Frederick Gowland Hopkins Memorial Lecture of the Chemical Society at the Society's rooms on February 19 at 7.30 p.m.

A SERIES of five lectures on aspects of atomic energy has been arranged by the London Branch of the Atomic Scientists' Association. The lectures will be given in the lecture hall of the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, at 7 p.m. on alternate Fridays, beginning February 6. Tickets (2*s*. 6*d*. for one lecture; 10*s*. for the series) can be obtained from Dr. L. E. C. Hughes, 15 Avenue House, Allitsen Road, St. John's Wood, N.W.8.

AN exhibition of War Office teaching aids, under the title "The Better Chance", will be open during February 3–11 in the Imperial Institute, South Kensington, London, S.W.7. This is an augmented version of the exhibition held at Eltham Palace on September 15 (*Nature*, **160**, 411; 1947). It is open to the public.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Cyclo-octatetraene

We have been engaged in an investigation of the structure of cyclo-octatetraene by X-ray methods. In a previous communication[1], we gave the preliminary crystallographic data. Cyclo-octatetraene crystallizes in the orthorhombic system with four molecules per unit cell. The cell dimensions are $a = 7{\cdot}76$ A., $b = 7{\cdot}80$ A. and $c = 10{\cdot}66$ A. The space group is *Aba*.

The work has now been carried further to the point where the essentials of the structure are known, and accounts of the structure have been presented at several scientific conferences[2,3,4].

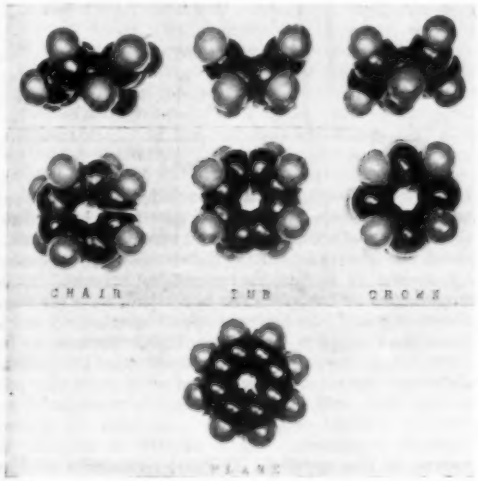

Fig. 1

Four structures can be postulated for the cyclo-octatetraene molecule (see Fig. 1): the 'crown' form —all *trans* configuration; the 'tub' form—all *cis*; the 'chair' form—half *cis*, half *trans*; and the 'plane' form, which presumes a large resonance energy to overcome the strain.

Raman and infra-red data obtained by Lord and Lippincott[5] led these investigators to favour the crown form. Similar experiments by Thompson[6] indicate the tub form to be most probable. Based on their recent electron diffraction study, Hassel[7] and co-workers conclude that the structure is the crown form with bond-lengths approximately those of benzene, suggesting a high degree of resonance.

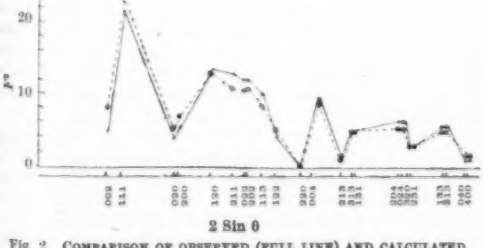

Fig. 2. Comparison of observed (full line) and calculated (broken line) F^2 values

Bragg–Lipson[8] structure factor charts proved very useful in our work. It was found that only the tub form with alternating single- and double-bonds gave a good fit with the experimental data (Fig. 2). The two-fold axis required by the space group must pass through the single bonds, and the bond-lengths are typically aliphatic: double-bond length, 1·34 A.; single-bond length, 1·54 A.; and C=C — C bond angle 125°. These values indicate little or no resonance energy in the cyclo-octatetraene molecule, which is in accord with the latest thermochemical data of Rossini[9] and co-workers.

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H. Mark

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Oct. 2.

[1] Kaufman, Fankuchen and Mark, *J. Chem. Phys.*, **15**, 414 (1947).
[2] American Society for X-Ray and Electron Diffraction, Quebec (June 1947).
[3] 11th International Congress of Pure and Applied Chemistry, London (July 1947).
[4] American Chemical Society, New York (September 1947).
[5] Lippincott and Lord, *J. Amer. Chem. Soc.*, **68**, 1868 (1946).
[6] Lecture at the Polytechnic Institute of Brooklyn (March 8, 1947).
[7] Bastiansen, Hassel and Langseth, *Nature*, **160**, 128 (1947).
[8] Bragg and Lipson, *Z. Krist.*, **95**, 323 (1936).
[9] Prosen, Johnson and Rossini *J. Amer. Chem. Soc.*, **69**, 2068 (1947).

Infra-Red Absorption Spectra of Crystals

Spectroscopic investigations on the scattering of light in crystals show very plainly that their vibration spectra have a discrete structure manifesting itself as a set of lines with sharply defined frequency shifts. That a similar discrete structure is also to be seen in the infra-red absorption spectra of crystals when examined under appropriate conditions is shown by a remarkable investigation by Barnes and Brattain[1]. These authors examined the case of magnesium oxide, which is a crystal of the cubic class with a structure similar to that of rock-salt. Plates obtained by cleavage from flawless transparent single crystals of large size were employed, and the absorption spectra of a whole series of such plates from the very thinnest obtainable to the thickest were investigated. The rock-salt spectrometer used in the study covered the wave-length range 1–15·6 μ, and the galvanometer deflexions were amplified 150 times by a photo-electric relay system. The resulting data showed the presence of some forty absorption lines in the wave-length range 6–15·5 μ. In the absorption curves reproduced with their paper, these lines are so sharply defined that their positions can be measured with high precision.

The theory of the vibration spectra of crystals worked out by me[2] leads to the result that crystals having the rock-salt structure have nine fundamental eigen-frequencies. These frequencies have now been evaluated theoretically, and their values for the case of magnesium oxide expressed as infra-red wave-lengths come out as 14·2, 14·7, 15·35, 17·1, 19·0, 21·1, 23·4, 38·5 and 54·5 μ respectively. All except the first three lie outside the range of a rock-salt spectrometer. Hence, except for the first three fundamentals, the absorption spectra recorded by Barnes and Brattain represent a superposition of the spectra of various orders higher than the first, in other words,

of the overtones and summations of the nine fundamental frequencies of vibration of the structure.

The changing aspect of the absorption curves with increasing thickness of the plate is readily understood on this basis. In the region of wave-lengths less than 7·1 μ, we are only concerned with the third-order absorption spectrum. This is necessarily weak and is, therefore, most marked when thick plates are used. Moreover, since the third-order frequencies are numerous and very close to each other, they are only imperfectly resolved. It is not surprising that, in these circumstances, the absorption by the thicker plates in the short wave-length region is registered as a smooth curve showing only minor fluctuations of intensity. In the region of longer wave-lengths, on the other hand, the confusion arising from the superposition of the third-order absorptions is less important. Since the infra-red activity is also much greater at such wave-lengths, thinner plates are necessary to avoid complete absorption and to enable the individual lines to be distinguished. An examination of the published curves, indeed, reveals the presence of the first three fundamentals, as also of the octaves of the first seven fundamentals with notable intensities in the theoretically predicted positions. Some twenty of the other observed absorption lines have also been identified as the summations of the fundamental frequencies taken two at a time.

Further details will appear shortly in the *Proceedings of the Indian Academy of Sciences*.

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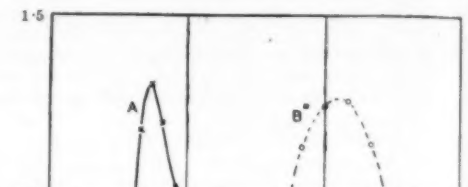
Nov. 21.

[1] *Phys. Rev.*, **48**, 582 (1935).
[2] *Proc. Ind. Acad. Sci.*, **18**, 237 (1943).

Thermal Mutual Inductance

When heat is dissipated from a hot body immersed in a fluid, the flow of heat is accompanied by a mechanical circulation of the fluid in the system of natural convection currents. The stored kinetic energy bestows on the heat current a property which has been termed 'thermal inductance', and curves I have obtained[1] for the thermal transients consequent on the sudden heating of a cylindrical body, or wire, immersed in a fluid, clearly show the influence of this inductive element. Experiments of this nature may, however, readily be extended to show the influence of a property which may be referred to as 'thermal mutual inductance'. If we take two parallel wires, one vertically above the other so that the same system of convection currents link both, then any change in the heat flow from one might be expected to influence the heat flow from the other. There are two such changes possible, a transient and a permanent one. A steady change in the heat flow from the upper wire consequent on a change in the heat flow from the lower simply represents the case of a hot-wire anemometer used to explore natural convection currents. If, however, our system is to exhibit a property of thermal mutual inductance, then we expect a transient change in the heat flow (or associated temperature difference) from the upper wire to accompany any change in the heat flow from the lower.

In a system of two parallel wires, the lower constituting the thermal primary and the upper the secondary, the primary input may be computed from the current flowing in the lower wire, and the secondary thermomotive force in terms of the temperature difference between the upper wire and the bulk of the fluid. This temperature difference can be measured by means of a fine thermocouple attached to the upper wire or by using the wire itself as a resistance thermometer. The former type of instrument may be somewhat suspect in work of this nature, as the instrument essentially measures the temperature difference between the wire and *some particular point* in the fluid, and any asymmetry in the heated convection current will clearly give rise to spurious thermal transients. As a matter of interest, the nature of the apparent thermal transients obtained with such a pair of thermocouple hot wires has been observed to vary somewhat with the size and shape of the containing vessel as well as with the nature and temperature of the fluid.



Resistance thermometer measurements are free from any suspicion that the transient observed is due to the rising heated column reaching different parts of the measuring instrument at different times, but are complicated by the fact that the steady rise in temperature of the whole fluid will also be recorded by the measuring device. Transients obtained from a pair of parallel nickel wires, 0·1 mm. diameter, 3·0 cm. long and 1·2 cm. apart, are shown in the accompanying figure. Concentrated solutions of sucrose were used on account of the low convective moduli associated with these solutions[2]. The curves represent the temperature rise of the upper wire plotted against the time elapsed since switching on the primary (thermal) current. Curves A, B and C refer to a 63 per cent (by weight) solution of sucrose in water at 23° C.; A with a primary heat flow of 5·0 watts, B 2·0 watts and C 0·95 watts. The curves B' and B'', shown dotted and broken respectively, also refer to results from a primary thermal current of 2·0 watts, B' in distilled water, a fluid of higher convective modulus than 63 per cent sucrose solution, and B'' in 68 per cent sucrose solution, a fluid of lower convective modulus, both again at 23° C.

All curves shown on the figure are of the same form. There is no immediate change in the secondary temperature following a switching on of the primary current. When, however, the heated column of liquid reaches the upper wire, there is a rapid rise in the temperature, which attains a maximum and then falls again. A subsequent slow rise in temperature is probably due to gradual heating of the whole bulk of fluid, as this last feature was not observed when using thermocouple type hot-wire instruments. From the curves shown it appears that the time taken for the thermal secondary to respond to a change in the primary is the longer the lower the primary current and the lower the convective modulus of the fluid.

There are several features of interest in this work. The time taken for the secondary to respond to a change in the primary is clearly a measure of the speed of the convection current, which is connected with the kinetic energy stored in the natural convection current and is thus related to the magnitude of the (self) induction associated with the flow of heat in fluids. Apart from the time-lag, the change in the primary current produces both transient and steady-state changes in the secondary, so that the pair of coupled hot wires constitutes a leaky thermal mutual inductance. The transient rise in temperature when the top of the convection column first reaches a temperature-recording instrument apparently means that the top of the column is at a higher temperature than the rest. Such a state of affairs is, however, only to be expected from the phenomena of thermal (self) inductance already observed. The delay in setting up a system of convection currents around a body the temperature of which is suddenly increased means that the initial part of the convection column has remained longer in contact with the hot body and is accordingly heated to a higher temperature than subsequent sections of the same column.

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Oct. 1.

[1] Bosworth, R. C. L., *Nature*, **158**, 309 (1946); *Phil. Mag.*, **37**, 803 (1946).
[2] Bosworth, R. C. L., *J. Roy. Soc. N.S.W.* (In the press).

Solar Noise

During a television outside broadcast from Brands Hatch, in Kent, during the afternoon of August 31, 1947, there appeared on the screens and from the loudspeakers of two television receivers situated in Ealing, London, and Claygate, Surrey, a sudden and intense increase of fluctuation noise. The visual effect was that of a violent snowstorm of the type well known to televiewers due to motor-car ignition interference, but at a very much more intense level than seen heretofore by either of the observers. The spots of noise upon the viewing screen were of slightly greater size than a line-width and in number something like 70–100 per scanning line. The intensity of the fluctuation noise interference was of such value that both receivers lost their line synchronization, though frame synchronization still held. The sound effect emerging from the loudspeakers was in no way distinguishable from a considerable increase in the fluctuation noise level. The phenomenon lasted about forty-five seconds at an intense level and then faded slowly away during a period of about fifteen seconds, the entire effect lasting about one minute. The fact that the interference appeared to be completely random in nature and also that it faded slowly away seemed to preclude any fault on the television transmission system.

Since observing this phenomenon, one of us visited Mr. J. S. Hey, of Operations Research Group, Ministry of Supply, West Byfleet, Surrey, who very kindly showed us his charts of recorded solar noise for the time of occurrence of the interference (August 31, 1947, between 3.30 p.m. and 4.0 p.m. British Summer Time). These charts showed considerable activity from the solar noise point of view in frequency-bands around 25 Mc./s., 73 Mc./s. and higher frequencies as well. As the charts were not capable of recording solar noise greater than about 10 μV./m. for the bandwidth of the receivers used for the recording, it is not possible to get an exact correspondence between the actual level of measured solar noise and the degree of interference in the television receivers. However, the charts did show, on several occasions during the half-hour period mentioned, a noise-level above the 10 μV./m. limit on them. The possible extent of interference from solar noise, though this may well be rarely encountered, can be surmised from the fact that the field-strength of television signals in the Ealing area is of the order of 3 mV./m. and in Claygate of the order of 1½ mV./m.

It would seem beyond reasonable doubt that the interference observed was, in fact, solar noise, particularly when the ratio of television band-width (5,000 kc./s.) to recording receiver band-width (about 20 kc./s.) is taken into account. A complete fade-out on many circuits was recorded by Cable and Wireless, Ltd., and the B.B.C. receiving station at Tatsfield at about the same time as the interference was observed.

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Use of High-frequency Current in Surgery

It has been remarked[1] that extended injury was caused to the brain of monkeys beyond the point of a needle electrode when using high-frequency current for surgical purposes. If the needle were of a ferrous material, such as steel, or a ferrous alloy, this may be expected, and is in accordance with our research experience over many years in experimental work on instruments for electrosurgical techniques, which involve the use of high-frequency currents, particularly for ophthalmic surgery using the Safar technique.

The main reason for the extended injury to tissues when using a ferrous wire, or needle, is due to the heating of the wire by eddy currents, and the increased resistance of the material which carries high-frequency current. As is well known, the D.C. resistance of a conducting material is given as

$$R_{DC} = l\rho/A,$$

where A is the cross-sectional area, l is the length and ρ is the specific resistance. The high-frequency resistance is given by:

$$R_{HF} = R_{DC} \times [1 + F(z)], \qquad (1)$$

where

$$z = \sqrt{8.\pi^2.r^2.\mu.f/\rho}. \qquad (2)$$

If $z > 3$,

$$F(z) = \tfrac{1}{4}(z\sqrt{2} - 3). \qquad (3)$$

If, by way of example, we consider a steel wire of 0·0126 cm. radius (r); specific resistance ρ of $11{\cdot}8 \times 10^3$ in c.g.s. units; permeability μ of 375; working frequency of $2{\cdot}0 \times 10^6$ c.p.s. and length l of 5·0 cm., then

$R_{HF} = R_{DC} \times 10{\cdot}261$, and $R_{DC} = 0{\cdot}1174$. Hence $R_{HF}/R_{DC} = 10{\cdot}261$.

This ratio is the important consideration in assessing the difference in temperature of the needle electrode when carrying high-frequency instead of direct current.

It is well known that the heat H generated in a conductor of resistance R, carrying a current I, is proportional to I^2Rt, and since the influence of high-frequency current is to increase the resistance, as indicated, this would appear to explain the statement in the report (*loc. cit.*) that when D.C. current was used the difficulties were mostly overcome. Ferrous metal becomes hot when carrying high-frequency current, and when hot metal contacts a biological substance it sticks and often causes injury by burning.

The ideal physical condition for operating electrodes carrying high-frequency current for surgical techniques is that they should remain practically at the temperature of the operating theatre, since they are only directors of the current to the site of operation. The surgical effect depends on the thermogenic property of the high-frequency arc at the point of the electrode.

In the case of wire electrodes this is accomplished by the use of 20 per cent iridium platinum alloy. For general purposes a diameter of about 0·025 cm. or slightly less appears to be most suitable. This alloy also offers the advantage that, with the use of 'Easi-flo' solder, a perfect joint can be formed with a German silver shank when the solder is melted in a hydrogen jet to prevent oxidation and ensure chemical wetting. Such a perfect joint is devoid of cracks and crevices, and thus prevents the ingress and trapping of germs.

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Sept. 29.

[1] Glees, Wall and Wright, *Nature*, **160**, 365 (1947).

Intracellular Determination of Protein by X-Ray Microspectrography

In a recently published paper[1], the possibility of making a determination of intracellular protein *in situ* was suggested. The analytical procedure was to be based on the binding of phosphotungstic acid by the protein and subsequent determination of the tungsten by X-ray microspectrography[2,3].

In a model experiment the amount of phosphotungstic acid which was combined with varying concentrations of protein has been determined. Protamine solutions of known concentration were precipitated with 5 per cent phosphotungstic acid, centrifuged and washed several times with distilled water. The precipitates were dissolved in alkali and the absorption of X-rays by the solutions was measured. 30,000-volt X-rays (minimal wave-length *c.* 0·4 A.) were used. The solution was placed in a cuvette with parallel walls of thin glass, and the thickness of solution was approximately 0·5 cm. The same cuvette was used for all measurements. The results are shown in Fig. 1, in which extinction coefficient is plotted against the amount of protein. (Extinction coefficient $E = \log I_0/I$, where I_0 is the intensity of the incident X-rays and I is the intensity of the transmitted X-rays.) As can be seen from the figure, there is a straight-line proportionality between the amount of protein and the extinction coefficient, which is proportional to the amount of tungsten bound to the protein. The extinction for zero concentration of protein was measured with the cuvette containing alkali of the same concentration as that used for dissolving the precipitates.

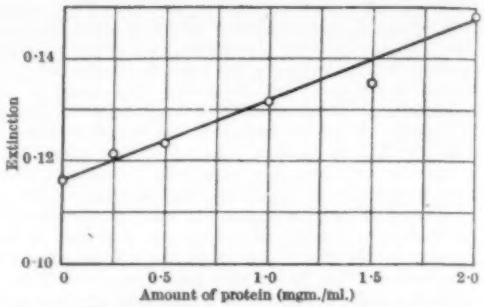

Fig. 1. The extinction as a function of the amount of tungsten bound to protamine

Microtome sections 10 μ thick of tissues of *Helix pomatia* and *Lophius piscatorius* (tissues fixed by freeze-drying) were treated with a solution of 2 per cent phosphotungstic acid (*p*H 2–2·5) for one minute, washed, dried and photographed with soft X-rays on fine-grained films. 3,250-volt X-rays were used, which correspond to a minimal wave-length in the continuous X-ray spectrum of *c.* 3·8 A. In these photographs the tungsten stands out in sharp contrast to the unstained tissue. Two photographs of ganglion cells from *Helix* are shown in Fig. 2; *a* was taken on Ilford High Resolution plate, and *b* on Eastman Spectroscopic plate 649. From these photographs it can be seen that the cytoplasm binds more phosphotungstic acid, under these conditions, than does the nucleus (the light areas in the photographs represent areas in the tissue which absorb X-rays strongly). Smaller structural elements appear in the nucleus. The relative amounts of tungsten bound by the protein within the cell may be obtained by measuring the absorption in different parts of the cell. If no phosphotungstic acid were bound by the protein, the extinction coefficient for a section of the

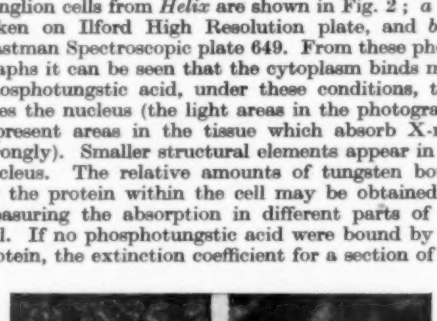

Fig. 2. Microradiograms of ganglion cells from *Helix* treated with phosphotungstic acid. (*a*) × 130; (*b*) × 260

tissue 10 μ thick and for the X-rays used would fall in the range 0–0·04, and the contrast would be very low.

It must be emphasized that many precautions must be taken before data so obtained may be translated into concentrations of intracellular protein. Further experiments are in progress to overcome some of the difficulties involved.

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Oct. 6.

[1] Engström, A., and Lindström, B., *Experientia*, **3**, 191 (1947).
[2] Engström, A., *Nature*, **158**, 664 (1946).
[3] Engström, A., *Acta Radiol.*, Suppl. 63 (1946).

Micro Estimation of Amino-Nitrogen and its Application to Paper Partition Chromatography

The present interest in the quantitative estimation of amino-acids in protein and peptide hydrolysates has prompted an early description of a method which it is felt may make some contribution to this problem.

The method described by Pope and Stevens[1] using copper phosphate for determining amino- and peptide-nitrogen has been successfully adapted to the determination of micro amounts (1–25 μgm.) of α-amino-nitrogen. The essential points of the method are that after the amino-acid has been allowed to react with copper phosphate, the soluble copper complex in the filtrate is decomposed by means of sodium diethyl-dithio-carbamate, the resultant characteristic golden yellow colour is extracted into amyl alcohol and the amount of copper determined absorptiometrically. The theoretical value of 0·44 for the ratio of α-amino-nitrogen to copper in the complex A_2Cu is not obtained under the experimental conditions in use, and it is essential to construct a standard curve for each individual amino-acid. Such curves are reproducible, and over their linear portion (10–25 μgm. α-amino-nitrogen) the amino-acids methionine, hydroxyproline, aspartic acid, leucine, isoleucine, histidine, phenylalanine, valine, glutamic acid, tryptophane and tyrosine give ratios lying between 0·50 and 0·55; alanine, glycine, threonine, serine, cystine and cysteine ratios between 0·55 and 0·80; and lysine, arginine and glucosamine ratios between 1·25 and 1·60.

The application of the method to the paper chromatograms of Consden, Gordon and Martin[2] has enabled quantitative recoveries of the component amino-acids of simple mixtures to be obtained. The technique employed is to localize the amino-acid on the chromatogram by use of a trial strip, as suggested by Dent[3], then cut out the square of paper containing the amino-acid. The square is folded, dropped into a test tube and the amino-acid treated with a suitable amount of copper phosphate sludge. The excess copper phosphate is filtered off, the copper in the filtrate determined by means of sodium diethyl-dithio-carbamate and its equivalent in α-amino-nitrogen obtained by reference to a standard curve for the amino-acid under investigation. Using this technique, a single-dimensional chromatogram of a valine/glycine mixture using *n*-butanol/water as the solvents gave recoveries of 94 per cent for glycine and 97 per cent for valine.

It has been found possible for ninhydrin to react with glycine and valine under conditions where almost no destruction of amino-nitrogen occurs, although enough colour is obtained to determine the position of the amino-acid on the chromatogram. Such development of colour did not affect appreciably the subsequent quantitative determination of α-amino-nitrogen. With single-dimensional chromatograms of a glycine/valine mixture, recoveries of 91 per cent for glycine and 93 per cent for valine have been obtained after reacting with ninhydrin. If the principle is found capable of extension to other amino-acids, it may be possible to avoid the use of trial chromatograms altogether, and this would be a great advantage in two-dimensional chromatography.

At the present time the errors of the estimation are such as to be well within the limits required for establishing the ratios of the amino-acid components of peptides.

A fuller report of this work will be published elsewhere.

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Oct. 10.

[1] Pope, C. G., and Stevens, M. F., *Biochem. J.*, **33**, 1070 (1939).
[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 244 (1944).
[3] Dent, C. E., *Biochem. J.*, **41**, 240 (1947).

Solvation of Hydrogen Ion in Oxygen-containing Solvents

The nature of non-aqueous solutions of the so-called 'strong' acids has received a good deal of attention; but although much information is now available regarding a number of individual solvent systems, comparatively little progress has been made in establishing quantitative scales of comparison of properties such as proton-availability in different solvents. A quantity suitable for this purpose is the acidity function first introduced by Hammett[1] to deal with concentrated aqueous solutions. The acidity function is a measure of the tendency of the medium to donate a proton to a neutral base and may be defined by

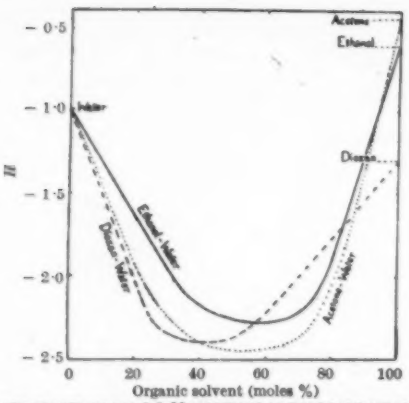
$$H = \log[BH^+]/[B] - \log K_B^{H_2O}, \quad . \quad (1)$$

where B is the proton-acceptor and BH^+ its conjugate acid, and where $K_B^{H_2O}$ is the equilibrium constant of the reaction

$$B + SH^+ \rightleftharpoons BH^+ + S \quad . \quad . \quad . \quad (2)$$

in water, SH^+ representing the solvated proton. It can be readily shown that $H = \log(\alpha c_A K_B^S / K_B^{H_2O})$, where c_A and α are the concentration and degree of dissociation of the acid, and K_B^S the equilibrium constant of reaction (2). The ratio $K_B^{H_2O}/K_B^S$ will be a measure of the proton-affinity of the solvent relative to water and can be calculated from H if α is known.

Using *m*- and *p*-nitranilines as proton-acceptors, H has been determined spectrometrically for solutions of hydrogen chloride in water, dioxan, ethanol and acetone, and their binary mixtures. The values of H for the four single solvents vary in the order dioxan < water < ethanol < acetone. These differences cannot be accounted for by differences in α, which can be estimated from conductivity measurements. The deduced values of $K_B^{H_2O}/K_B^S$ vary in the



ACIDITY FUNCTIONS FOR 0·1 *M* SOLUTIONS OF HYDROGEN CHLORIDE IN WATER–ORGANIC SOLVENT MIXTURES

order water (1·0) > dioxan (0·45) > ethanol (0·29) > acetone (0·10), which is the sequence to be expected from simple considerations of electron availability at the oxygen atom in the series ether > alcohol > water > ketone, except that the position of water is anomalous.

In water-organic solvent mixtures, H shows non-linear variations with solvent composition, passing through a minimum in the region of equal molar proportion of the two components (see diagram). This is in sharp contrast to ethanol-acetone and ethanol-dioxan mixtures, where no such minima are observed. The anomalous behaviour of the partly aqueous solutions may be explained in terms of the abnormally high proton-affinity and exceptional intermolecular structure[2] of water. In aqueous solution the protons are accommodated in the interstices of the quasi-crystalline tetrahedral lattice and simultaneously bound to four surrounding oxygen atoms. On the addition of the organic solvent, the tetrahedral structure will be gradually broken down by the interposition of organic solvent molecules, and hydrogen-bonding between neighbouring water molecules will be replaced by much weaker hydrogen-bonding with organic solvent molecules. The density of packing will increase, and the protons will be preferentially surrounded by the smaller water molecules. As a result of the decreased extent of intermolecular hydrogen bonding and the closer packing, the effective proton-affinity of the water molecules will increase, and $K_B{}^S$ and H will fall. The breakdown of the tetrahedral structure will be more rapid the larger the organic solvent molecules and, in agreement with this picture, the slopes of the left-hand parts of the acidity function – solvent composition curves (see diagram) increase in the order ethanol < acetone < dioxan. When the concentration of organic solvent is increased beyond 50 mol. per cent, organic solvent molecules begin to predominate in the medium and eventually replace the aqueous solvation shell. Since intermolecular structure and hydrogen-bonding is much less pronounced in ethanol than in water[3], and presumably almost entirely absent in dioxan and acetone, the organic solvents will only exert 'normal' proton affinities derived from the interaction of protons and discrete solvent molecules. On the right-hand parts of the acidity function – solvent composition curves, H therefore increases with decreasing water content to its value in the anhydrous solvent.

The conclusion that water has an abnormally high proton-affinity is in agreement with other evidence[4]. The variations in acidity function with solvent composition are paralleled by corresponding variations in other properties such as electrical conductivity[5], heats of transfer[6] and catalytic constants[7], which may all be similarly explained in terms of the changes in the state of solvation of the hydrogen ions.

A detailed account of this work will be published elsewhere.

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[1] Hammett and Deyrup, *J. Amer. Chem. Soc.*, **54**, 2721 (1932). Hammett and Paul, *ibid.*, **56**, 827 (1934). Lewis and Biegeleisen, *ibid.*, **65**, 1144 (1943).
[2] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515 (1933).
[3] Pierce and MacMillan, *J. Amer. Chem. Soc.*, **60**, 779 (1938).
[4] Goldschmidt, *Z. phys. Chem.*, **60**, 728 (1907); **89**, 129 (1915). Lapworth and Partington, *J. Chem. Soc.*, **97**, 19 (1910). Heston and Hall, *J. Amer. Chem. Soc.*, **56**, 1462 (1934).
[5] Schukov and Dneprov, *J. Gen. Chem. Russ.*, **8**, 1476 (1938). Bezman and Verhoek, *J. Amer. Chem. Soc.*, **67**, 1330 (1945). Owen and Waters, *ibid.*, **60**, 2371 (1938). Hartmann, *Z. phys. Chem.*, A, **191**, 197 (1941).
[6] Butler and Robertson, *Proc. Roy. Soc.*, A, **125**, 694 (1929).
[7] Braude, *J. Chem. Soc.*, 443 (1944). Braude, Jones and Stern, *ibid.*, 396 (1946). Braude and Stern, *ibid.*, in the press.

Critical Temperature and Molecular Weight of *n*-Paraffins

INVESTIGATIONS on the viscosity of liquids and gases showed that the viscosity at the critical point, η_c, should be given by

$$\eta_c = K \frac{\rho_c{}^{2/3}}{M^{1/6}} T_c{}^{1/2}, \quad . \quad . \quad . \quad (1)$$

where K is a universal constant, ρ_c is the critical density, T_c is the absolute critical temperature, and M is the molecular weight.

A correlation of the viscosity of *n*-paraffins under saturation pressure with the ratio T/T_B (T is the

Fig. 1

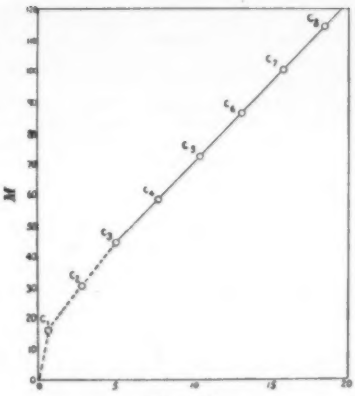

Fig. 2

absolute temperature; T_B is the absolute atmospheric boiling temperature) yielded the chart shown in Fig. 1. From the figure it seems that η_c has very nearly the same value for all the *n*-paraffins between C_3 and C_8. It will further be found that for these substances ρ_c has the same value of approximately 0·23 gm./c.c. From equation (1) it can be deduced that, if η_c and ρ_c are nearly the same for the *n*-paraffins, then $T_c^{2/3}$ should be proportional to $M^{1/6}$ or

$$T_c^3 \propto M.$$

The linear relationship between T_c^3 and M for the *n*-paraffins above C_3 is illustrated in Fig. 2.

Now since M is generally an additive property, T_c^3 should also be an additive property for the *n*-paraffins above C_3. The increment of T_c^3 equivalent to $-CH_2-$ is about $2{\cdot}7 \times 10^7$.

It is interesting to note the position of the points for methane and ethane in Fig. 2. The increment for $-CH_2-$ between methane and ethane and between ethane and propane is $2{\cdot}1$ and $2{\cdot}2 \times 10^7$ respectively, while the value of T_c^3 for methane is only $0{\cdot}69 \times 10^7$. Thus it seems that the value of T_c^3 reflects the 'flexibility' of the hydrocarbon chain, namely, the number of internal degrees of freedom. This number is small for methane, and increases with the chain-length. For the *n*-paraffins higher than propane, the increase is proportional to the number of $-CH_2-$ groups present in the molecule.

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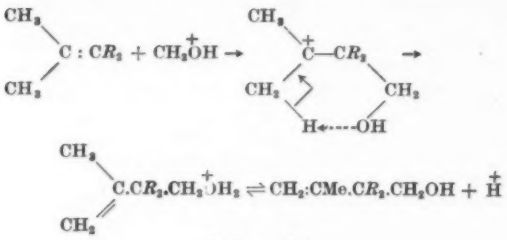
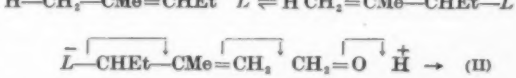
Olefine Reactions Catalysed by Lewis Acids

In a recent monograph[1], C. C. Price refers to a publication by me[2] in which reference was made to the formation of unsaturated alcohols of the general type $CR_2 : CR.CH_2.CH_2OH$ by the catalysed reaction[3] of formaldehyde with the olefines $CR_2 : CR.CH_3$. Price states, "The reaction . . . has been interpreted as involving attack at the 'active' α-position of the double bond; but it is very difficult to account for the catalytic effect of acids by such a mechanism. It seems much more likely that all the reactions involve a similar intermediate." This common intermediate is $> \overset{+}{C} - CH - CH_2OH$, formed by the addition of the formaldehyde cation $CH_2\overset{+}{O}H$ to the olefinic bond. The formation of 3-methyl-Δ^3-buten-1-ol from *iso*butylene is then formulated thus:



(I, $R_2 = H_2$)

Quite apart from the fact that such a mechanism still involves an 'active' α-methylenic hydrogen atom, there are specific objections to such a view. First, this mechanism only gives the correct structure for the reaction product when the olefine is of the type $CH_2.CR : CH_2$, because, in such cases, it is impossible to differentiate structurally between a $=CH_2$ group formed from the initial CH_2 group and the $=CH_2$ group of the parent olefine. The British patent[3] states that the reaction is valid for *all* olefines of the type $CRR' : CR''.CH_3$. Thus, 2-methyl-Δ^2-pentene should, by Price's mechanism, afford 2-ethyl-3-methyl-Δ^3-buten-1-ol (I, R_2=H, Et). The product obtained is stated to be 3-methyl-Δ^3-hexen-1-ol, $CHEt : CMe.CH_2.CH_2OH$ (II), the expected product from a mechanism



Secondly, the British patent states specifically that "the catalyst is non-acidic", meaning by this that no *hydrogen* acid is present. The reaction is effected in aprotic solvents and the effective catalysts are molecules like stannic chloride, etc., which are strong acids in the Lewis sense[4].

The validity of this argument has been challenged[5] on the grounds (i) that no evidence for the structure of the unsaturated alcohol (II) is given in the British patent, and (ii) that minute traces of the proton-donator, water, might well be present under the experimental conditions employed. The essential feature of the mechanism which is challenged by Price is that addition of a Lewis acid to an olefine can cause direct separation of a proton from the olefine in the presence of a proton-accepting reagent[6]. In the reaction between phenyl *iso*cyanate and trimethylethylene in the presence of stannic chloride under conditions which were proved to be rigorously anhydrous[6], considerable stannic chloride-catalysed polymerization of the olefine also occurs. The dimeride fraction of this polymeride, on ozonolysis, affords *only* acetaldehyde (: CHMe end-group) and a mixture of two isomeric methyl hexyl ketones, separated by fractional crystallization of their semicarbazones into two pure products, m.p. 174° and 154°, respectively. The ketone giving the semicarbazone, m.p. 174°, has now been proved, by direct

comparison with a synthetic specimen, to possess the structure (IV), derived from the dimeride (III), in which one molecule of trimethylethylene has added on as the fragments $\overset{+}{H}$ and $\overset{-}{CH_2}.CMe:CMe_2$ to a second molecule, polarized in the normal direction. It is difficult to explain the formation of a dimeride of structure (III) except by a mechanism which involves the direct separation of an α-methylenic proton from the olefine, already activated by hyperconjugation[7], under the influence of the Lewis acid ($L = SnCl_4$), thus :

$$H{-}CH_2 \cdot CMe : CHMe + L \rightarrow$$

$$\overset{+}{H}\ \overset{\delta-}{CH_2} : CMe{-}CHMe{-}\bar{L} + \overset{\delta+}{CMe_2} : \overset{\delta-}{CHMe} \rightarrow$$

$$CHMe : CMe{-}CH_2{-}CMe_2{-}\bar{C}HMe + \overset{+}{H} \rightarrow$$

$$CHMe : CMe.CH_2CMe_2Et \xrightarrow{O_2}$$

III

$$MeCHO + MeCOCH_2.CMe_2Et$$

IV

If, as required by Price's mechanism, the sole function of the Lewis acid catalyst were to produce a carbonium cation $\overset{+}{C}Me_2{-}CHMe{-}\bar{L}$, the initial dimerization should occur to give the intermediate $\overset{+}{C}Me_2.CHMe.CMe..CHMe_2{-}\bar{L}$, which could not give the structure (III) by any acceptable proton migration. The most probable rearrangement of such an intermediate would be

$$\overset{+}{C}Me_2{-}CMe.CMe_2{-}CHMe{-}\bar{L} \rightarrow$$

$$\overset{+}{H}\ CMe_2{=}CMe{-}CMe{-}CHMe\ {-}\bar{L} \text{ (pinacolic change)} \rightarrow$$

Me

$$CHMe_2.CMe_2.CMe : CHMe \xrightarrow{O_3} Me.CO.CMe_2Pr^{\beta}$$

V

Although the structure of the second ketone (semicarbazone, m.p. 154°) has not yet been established, it has been proved by direct comparison with a synthetic specimen that it is *not* identical with the ketone (V), which, incidentally, gives a semicarbazone, m.p. 153°, depressed to m.p. 139–140° by admixture with that of the ozonolysis ketone.

A fuller account of this work will be published elsewhere when the structure of the second methyl hexyl ketone has been established.

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[1] "Reactions at Carbon-Carbon Double Bonds", 45 (Interscience Publishers, Inc., New York, 1946).
[2] Baker, *J. Chem. Soc.*, 296 (1944).
[3] Brit. Pat. No. 545,191 (1942).
[4] *J. Franklin Inst.*, **226**, 293 (1938).
[5] Price, private communication.
[6] Baker and Holdsworth, *J. Chem. Soc.*, 724 (1945).
[7] Baker and Nathan, *J. Chem. Soc.*, 1844 (1935). Baker, *J. Chem. Soc.*, 1150 (1939). Mulliken, Rieke and Brown, *J. Amer. Chem. Soc.*, **63**, 41 (1941)

Formation of Hydroxy Peroxides

THE reactions of hydrogen peroxide, and alkyl hydrogen peroxides, with organic compounds are usually regarded as homolytic processes. This note outlines evidence which suggests that the peroxidations of aldehydes are almost certainly of a heterolytic character. In such reactions, hydrogen peroxide behaves as a nucleophilic reagent, attacking through its anion HO_2^-, just as hydrogen cyanide attacks[1] through its anion CN^-.

As evidence in favour of this mode of attack, we find, using a spectroscopic method, that the formation of hydroxy alkyl peroxides from aldehydes with hydroperoxides is catalysed by bases such as pyridine, and by acids, and proceeds more rapidly in organic solvents such as ether than in the gas-phase; the reaction is insensitive to illumination by daylight. Various workers[2] have shown that, with reservations regarding formaldehyde, these reactions are reversible.

We formulate the reactions thus :

In basic or neutral solutions :

$$H_2O_2 \rightleftharpoons HO_2^- + H^+ ;$$

$$R.C(H)(=O) + HO_2^- \rightleftharpoons R.C(H)(O{-}OH)(O^-) \overset{H^+}{\rightleftharpoons} R.C(H)(O{-}O{-}H)(OH) ;$$

$$R{-}C(H)(OOH)(OH) \rightleftharpoons H^+ + R{-}C(H)(OOH)(O^-) \xrightleftharpoons{R{-}CHO}$$

$$R{-}C(H)(OH){-}O{-}O{-}C(H)(O^-){-}R \overset{H^+}{\rightleftharpoons} R{-}C(H)(OH){-}O{-}O{-}C(H)(OH){-}R.$$

In acid media :

$$R{-}C(H)(=O) + H^+ \rightleftharpoons R{-}C^{\oplus}(H)(OH) ;$$

$$R{-}C^{\oplus}(H)(OH) + H{-}O{-}O{-}H \rightleftharpoons R{-}C(H)(OOH){-}OH + H^+ ;$$

$$R.C(OH)(H){-}OOH + R.C^{\oplus}(H)(OH) \rightleftharpoons R{-}C(H)(OH){-}O{-}O{-}C(H)(OH){-}R + H^+.$$

Further investigations of these and other nucleophilic reactions of hydroperoxides are in progress.

It has come to our notice, immediately before this letter was submitted, that Dr. Style and his coworkers at King's College, London, are investigating

the reactions between hydrogen peroxide and aldehydes in water.

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[1] Lapworth, *J. Chem. Soc.*, 995 (1903); 120 (1904).
[2] Ghijsen, Dissertation, Delft (1942). Reiche, "Alkylperoxide und Ozonide" (Leipzig, 1931).

Reaction between Manganous Ion and Manganese Dioxide

The decrease of manganous ion concentration which occurs when a manganous salt is shaken with manganese dioxide has been known for a long time. Being most marked with freshly precipitated oxides, it is not surprising it should first have been considered an adsorption. For some time this observation has found practical application in the removal of soluble manganese in water supplies[1], while recently it has been shown of significance in the chemistry of the dry cell depolarizer[2], and also in the oxidation-reduction cycle of manganese in the soil[3,4].

In all instances the primary reaction is probably

$$MnO_2 + Mn^{++} + 4H^+ = 2\,Mn^{+++} + 2H_2O.$$

Except in the presence of concentrated acid, the equilibrium is such that the amount of Mn^{+++} is very small. In the presence of pyrophosphoric acid, which forms a stable complex anion with trivalent manganese[5], the reaction may proceed far to the right[4]. In the absence of complex-forming substances and in neutral and slightly alkaline solutions, a new solid phase appears, the reaction again proceeding to the right. One solid phase which has been observed at *p*H values as low as 4·5 has been identified as manganite[3]. Its formation may be shown by rewriting the above equation so as to assume hydrolysis of the manganic ion, thus

$$MnO_2 + Mn^{++} + 2H_2O = 2MnOOH + 2H^+.$$

Dion and Mann[3] state the reaction proceeds only in the reverse direction. This is contrary to the above findings[3] and to our own. In seeking a cause for potential drift with a manganese dioxide electrode[7], we have found that some such reaction proceeds even when the dioxide has the dense heat-stable pyrolusite structure; that it leads to the production of a lower oxide even at *p*H values as low as 1; and that this oxide has a structure not previously described.

Half-gram portions of dioxide obtained by heating pure manganous nitrate were allowed to stand for two days at room temperature with 50 ml. of the solutions shown in the accompanying table. The solid residues after washing and drying at room temperature *in vacuo* were examined by one of us (J. M. C.) by both the X-ray and electron diffraction methods. In each instance the X-ray powder pattern showed only the lines of pyrolusite. However, the electron diffraction pattern from the sample treated with hydrochloric acid and manganous chloride had rings distinctly different from those of pyrolusite. The other treated samples gave a pyrolusite pattern, but in addition showed weakly the stronger rings of the new pattern. When manganese dioxide is dissolved in concentrated hydrochloric acid and the manganese tetrachloride hydrolysed, this new pattern is not obtained, but rather the pattern of γMnO_2 or of pyrolusite[6].

Reactants	X-ray diffraction pattern	Electron diffraction pattern
Original MnO_2	pyrolusite	pyrolusite
MnO_2, $MnCl_2$ 0·1 *M*, HCl 0·1 *M*	pyrolusite	pyrolusite and new oxide (strong)
MnO_2, HCl 0·1 *M*	pyrolusite	pyrolusite and new oxide (weak)
MnO_2, $Mn(ClO_4)_2$ 0·1 *M*, $HClO_4$ 0·1 *M*	pyrolusite	pyrolusite and new oxide (weak)

The rings of the new pattern given by the sample treated with hydrochloric acid and manganous chloride show arcing when the specimen is tilted, most of the arcs lying along one diameter. This indicates that the substance is in the form of thin flakes, of the order of 100 A. or less in thickness, lying flat on the supporting film of collodion. It seems probable that these flakes were formed by the breaking-off of an altered surface layer from the particles during the process of grinding the sample under secondary butyl alcohol. Lattice spacings and ring intensities are given below.

D	Int.	*D*	Int.
5·1	W	1·74	M
4·39	S	1·62	M
4·12	S	1·58	MW
3·34	W	1·50	W
2·46	S	1·30	W
2·35	M	1·27	MW
2·06	MW		

This pattern is similar to that of goethite, $\alpha FeOOH$, and there is good agreement between the observed spacings and those calculated for an orthorhombic cell with dimensions $a = 4·42$, $b = 10·4$, $c = 2·83$ A., which are close to the dimensions of the goethite cell. However, interpreted on this basis, some reflexions are present which are not permitted by the space group of goethite, and some reflexions given by goethite are absent. Hence the substance cannot be considered as truly isomorphous with goethite. The data are not sufficient to allow a more definite determination of structure. Recently Gruner[8] has briefly described a new mineral (groutite) found in Minnesota which has the cell dimensions $a = 4·56$, $b = 10·70$, $c = 2·85$ A. It is considered, however, that these dimensions differ significantly from those of the oxide described here. No manganese analogue of goethite is reported by Dana, who lists the groups:

goethite ($\alpha FeOOH$), diaspore ($\alpha AlOOH$),
lepidocrocite ($\gamma FeOOH$), boehmite ($\gamma AlOOH$),
manganite ($\gamma MnOOH$).

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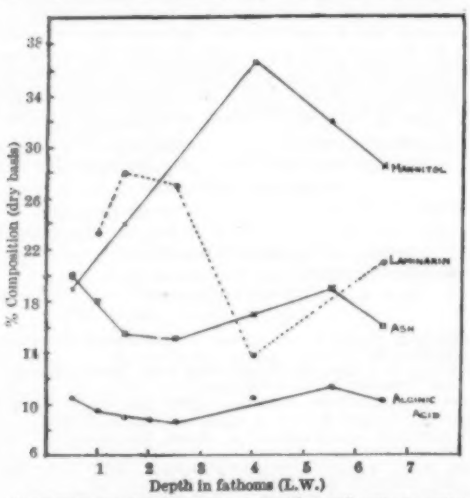
[1] Tillmans, J., Hirsch, P. and Häffner, F., *Das Gas und Wasserfach.*, **70**, 26 (1927).
[2] McMurdie, H. F., Craig, D. N., and Vinal, G. W., *Trans. Electrochem. Soc.* (Preprint), **90**, 31 (1946).
[3] Dion, H. G., and Mann, P. J. G., *J. Agric. Sci.*, **36**, 239 (1946).
[4] Heintze, S. G., and Mann, P. J. G., *Nature*, **158**, 791 (1946).
[5] Kolthoff, I. M., and Watters, J. I., *Indust. Eng. Chem. Anal. Ed.*, **15**, 8 (1943).
[6] Cole, W. F., Wadsley, A. D., and Walkley, A., *Trans. Electrochem. Soc.* (Preprint), **92**, 2 (1947).
[7] Wadsley, A. D., and Walkley, A., unpublished work (1947).
[8] Gruner, J. W., *Amer. Min.*, **30**, 169 (1945).

Seasonal Variation in Chemical Constitution of some Common British Laminariales

It is well known that seaweed, vast quantities of which grow around the coast of Scotland, undergoes wide seasonal variation in chemical constitution. Very little use has been made of these seaweed resources, which may be due to the fact that in Britain they have never been studied intensively from a chemical point of view, and no simple analytical methods have been available for the estimation of the various constituents. The future of any seaweed industry now depends on a thorough knowledge of the organic constituents, which are mainly polysaccharide in nature, and it is the latter which are subject to such wide seasonal variation. It is important, therefore, that the variation of the chemical constituents throughout the year be known, so that the seaweed may be harvested at the appropriate period in order that the constituent required will be at its maximum.

During the past three years, the Scottish Seaweed Research Association has each month been collecting, off the west coast of Scotland and in the Orkneys, samples of the principal British Laminariales. Before drying and preparing the plants for analysis, they are separated into fronds and stipes and analysed individually. Previous workers[1] have apparently analysed the whole plant, and they give no details of the methods of sampling, drying, etc., which are of great importance in plant analysis. During our investigations, every effort has been made to collect the plants from the same habitat and to dry and prepare the samples for analysis under controlled conditions.

Our results have shown that the wide seasonal variations in constitution previously recorded are due almost entirely to variations in the composition of the fronds, which are annual, whereas the stipe is perennial, and it is in the frond where most of, if not all, the photosynthesis occurs. In the spring of each year the frond is renewed, when its composition is approximately the same as that of the stipe; that is, high in mineral matter, proteins and alginic acid; low in mannitol, and containing no laminarin. As photosynthesis proceeds, the mannitol accumulates in the frond and reaches a maximum about midsummer, while laminarin reaches a maximum in the late autumn when the mineral matter is at a minimum and the dry-weight content at a maximum.



Variation in composition of *L. Cloustoni* fronds from Orkney with depth of immersion (August, 1946)

It is interesting to note that, in all the samples analysed, very little or no laminarin was found in the stipes; and it is quite probable that it is entirely absent.

Variation in chemical composition, however, depends on another important factor, the depth of immersion of the seaweed. The relationship between the depth of immersion of Algæ and their metabolism, as expressed by their chemical composition, has previously been noted by Haas and Hill[2] and Barbara Russel-Wells[3], who found a direct increase of fats and fat-like substances with degree of emergence and an increase in the unsaponifiable residue with depth of immersion. No other work appears to have been carried out on this important aspect.

In August 1946, samples of *L. Cloustoni* were taken from the Orkney waters at depths of ½–6½ fathoms (dead low water ordinary spring tides), and the analysis of the fronds, given in the accompanying graph, show remarkable variations.

The mannitol content (36·7 per cent), even when expressed on the whole plant, is considerably greater than any figure previously recorded. In addition, the iodine content increases with depth of immersion and reaches the remarkable figure of 1·25 per cent (on the anhydrous basis) at 7½ fathoms.

Further samples of the *Laminaria Cloustoni*, *Laminaria digitata* and *Laminaria saccharina* have been taken in Orkney in May and July of this year, and the results so far obtained support the previous findings.

This work is being continued and a more detailed report will be published later.

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Oct. 14.

[1] Lapicque, M. L., *C.R. Acad. Sci. Paris*, **169**, 1426 (1919). Colin, H., and Ricard, R., *C.R. Acad. Sci. Paris*, **190**, 1514 (1930). Ricard, R., *Bull. Soc. Chem. Biol.*, **13**, 417 (1931). Lunde, G., *Z. ang. Chem.*, **50**, 731 (1937); *Papir J.*, **28**, 147 (1940). Dillon, T., *Chem. Age*, **49**, 279 (1943).

[2] Haas, P., and Hill, T. G., *Ann. Bot.*, **47**, 55 (1933).

[3] Barbara Russel-Wells, *Nature*, **129**, 654 (1932).

Aerobic Mesophilic Bacteria in Composts

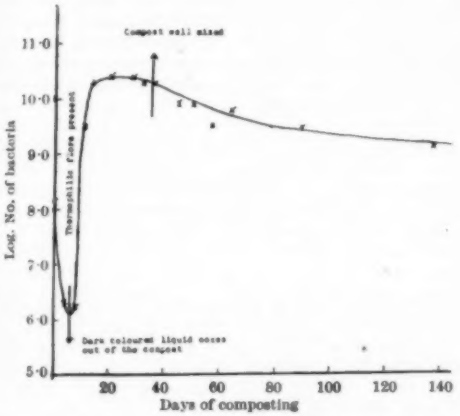
In a previous communication[1], an account was given of the activity of the thermophilic flora which develops in composts made from grass cuttings (lawn mowings). This thermophilic flora can be seen as a white coating on the cuttings, particularly in the upper layers during the high-temperature phase. From it true and facultative thermophilic bacteria were isolated. Recently, in addition, evidence of the presence of a thermophilic actinomycete has been obtained (cf. Waksman *et al.*[2]).

The object of this communication is to give a general account of the behaviour of the aerobic mesophilic bacterial flora of this type of compost. The accompanying table gives the results of bacterial counts using the dilution plate technique (plates incubated at 25° C. for seven to nine days) obtained from samples taken from the centre of composts at different times during the composting period. The moisture content remained practically constant throughout this period.

No. of days of composting	Internal temp. of compost	Bacterial numbers (millions per gm. fresh material)		
0 (fresh cuttings)	20° C.	155×10^6;	117×10^6;	37×10^6; 35×10^6
2	65° C.	$2{\cdot}2\times10^6$;	$2{\cdot}16\times10^6$;	$3{\cdot}7\times10^6$
4	54·4° C.	$17{\cdot}48\times10^6$;	$3{\cdot}68\times10^6$;	$3{\cdot}84\times10^6$
11	30° C.	$3{,}275\times10^6$		
28	15° C.*	$13{,}000\times10^6$;	$12{,}100\times10^6$;	$5{,}750\times10^6$
64	15° C.*	$10{,}385\times10^6$;	$11{,}815\times10^6$;	$11{,}500\times10^6$

* Reached outside temperature

It will be seen that there is a reduction of the mesophilic bacterial flora present on the fresh material at the high-temperature phase (65–55° C.). When the temperature of the heap falls below this, there is a very striking development of the mesophilic flora. The general picture of the bacteriology of this type of composting can best be shown by plotting the logarithm of the bacterial numbers against the days of composting.



CHANGES IN THE AEROBIC BACTERIAL FLORA (DEVELOPING ON NUTRIENT AGAR) DURING THE COMPOSTING OF GRASS CUTTINGS. CURVE REFERS TO MESOPHILIC BACTERIA

A similar course of events has been found with the mesophilic flora of a straw compost prepared following the principles of Hutchinson and Richards[3]. In the case of straw, however, no liquid appears during the composting (at least under our conditions), and the development of a thermophilic bacterial flora is not so obvious.

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[1] Webley, *Nature*, **159**, 35 (1947).
[2] Waksman, Umbreit and Cordon, *Soil Sci.*, **47** (1), 37 (1939).
[3] Hutchinson and Richards, *J. Min. Agric.*, **28**, 398 (1921).

Pre-erythrocytic Stage in Mammalian Malaria Parasites

Shortt and Garnham have announced [*Nature*, January 24, p. 126] the discovery of plasmodial masses in the livers of two monkeys six and seven days respectively after inoculation with sporozoites of *Plasmodium cynomolgi*. These plasmodial masses apparently form the long-sought pre-erythrocytic stage of mammalian malaria parasites, and it is to be expected that human malaria parasites will show similar developmental changes in the incubation period of an infection. Prof. Shortt has very kindly shown me his preparations, and I write to confirm his discovery by the finding of similar parasites in my own laboratory.

For several years we have studied the life-cycle of avian and simian malaria parasites, and biological information has been collected about development of *P. cynomolgi*. After the injection of sporozoites into the skin of monkeys, sporozoites have been demonstrated microscopically at the site of injection for 4½ hours but not longer; these sporozoites lie extracellularly and probably represent forms which fail to develop further. By subinoculation, sporozoites have been demonstrated in the blood of a limb (in which circulation had been arrested by a tourniquet) as late as two hours after intradermal injection. Following this initial period (as is well known) the blood ceases to be infective on subinoculation for approximately eight days. The time at which infectivity returns is sharply defined. Monkeys inoculated with blood taken at 7 days 21 hours, at 7 days 15 hours, and at many shorter periods never became infected; monkeys inoculated with blood taken at 7 days 23 hours, 8 days 4 hours, or longer periods did become infected. Meticulous examination of blood films between the eighth and thirteenth day of the infection showed that the entry of parasites into the blood stream was not synchronous but that it was a continuous process spreading over several days. Subinoculation of tissues (including liver) from monkeys during the inoculation period was done repeatedly; but no transmission was ever achieved with tissue removed less than 7 days 23 hours after the injection of sporozoites. The tissue forms were not transmissible by this means.

Our attempts to locate and identify the tissue forms were unsuccessful until Prof. Shortt's kind demonstration of this preparation. On re-examination of our sections, forms similar to those he has described have been found in the livers of three monkeys. In one experiment, a three months old rhesus monkey was inoculated intravenously and parenterally with the glands from 120 infected mosquitoes. It was killed 7 days 23 hours later. The blood, liver, lung and spleen respectively were infective to other monkeys, but other organs did not produce infection. Large plasmodial masses (average diameter about 28 μ) have been found in the liver; this monkey had been bred in the laboratory, so there could be no question of some other natural infection acquired in India. Similar forms have been found in the liver of a monkey killed 7 days 15 hours after the intravenous injection of the ground-up thoraces of 1,000 infected mosquitoes; the blood and organs were not infective for other monkeys. A third monkey was inoculated intravenously with a suspension of 40 infected mosquitoes (ground up), and it was killed exactly five days later. The blood, liver and other organs did not infect monkeys into which they were sub-inoculated, but parasites (average of longest diameter 14 μ) have been found in the parenchymatous cells of the liver.

In all these cases, parasites are much more scanty and difficult to find in smears than in sections. Further investigation is proceeding.

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Variations in Spermatogenesis of Oligospermic Men

In two cases of barren marriage due to severe oligospermia of the husbands, pregnancy occurred notwithstanding spermatic counts of 5,200,000 and 10,000,000 per c.c. Owing to the fact that both couples were extremely religious Jews, extra-conjugal relations could be excluded. Since fertilization with such low spermatic counts seemed improbable, it occurred to us that variations in the spermatogenetic function occur in certain cases of oligospermia. Thus, fertilization might take place at a time when higher spermatic levels are reached.

We have, therefore, examined a group of twenty-one men selected on the basis of a very low spermatic count on first semen examination (less than 10 million per c.c. in twelve cases, less than 20 million per c.c. in five cases and less than 30 million per c.c. in four cases). The total number of spermatozoa in the ejaculate was less than 90 million per c.c. in each. In all these cases the wives were excluded as responsible for barrenness. In order to study the spermatogenic function, five to seven semen analyses were performed in each case. Each specimen was taken after a period of abstinence of five days.

These semen analyses revealed two types of spermatogenesis in this series. In the first type (thirteen cases) the spermatozoal count was fairly constant, and the differences between any two spermatic counts did not exceed 12 million per c.c. The other seminal characteristics associated with spermatogenesis (sperm motility and percentage of normal spermatozoal) were also quite constant. In the second type (eight cases), extreme variations in the spermatozoal count were observed on repeated examinations. These variations in the spermatic density were as much as 43·5 million per c.c. in the same patient, at different examinations. In five of these cases values as high as 60 million per c.c. were reached. The other spermatic characteristics (motility and morphologically normal spermatozoa) also showed significant variations, although not so striking as the spermatic density.

During the period of observation (4–23 months) conception occurred in two of these barren marriages. In both cases the husbands belonged to this second type of oligospermia.

These observations lead us to distinguish between two types of oligospermia: (1) constant oligospermia, characterized by constancy of a poor spermatogenetic function; and (2) periodic oligospermia, characterized by periodic variations in spermatogenic characteristics, so that in one or more of a series of semen analyses normal values may be reached. Fertilization in this type of oligospermia may well occur.

The value of any therapeutic agent in the treatment of oligospermia should be studied only in cases of constant oligospermia. In view of the above reported observations, many therapeutic reports in cases of oligospermia might be considered as doubtful.

A detailed report of this study will be published elsewhere.

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Honeydew on Lime Trees

The dry summer of 1947 led to the accumulation of large amounts of honeydew secreted by the aphis *Therioaphis tiliæ* (L.) on the leaves of European lime trees. Sufficient often dripped to the earth to give a hard coating to the surface.

Portions of leaves (40 gm. dry weight) were gathered by tearing off the edges bearing the honeydew, which had sometimes dried to form a white solid. The leaves were steeped in cold water for 30 min. and the extract (440 ml.) filtered, giving a clear, slightly green liquid. Soil (230 gm.) was scraped from beneath a lime tree and extracted with 200 ml. water. After being heated on the water bath for 45 min. the extract was centrifuged and filtered, yielding a clear, green-brown solution.

Total fructose was estimated in these extracts by the method of Corcoran and Page[1], and reducing sugars were determined, before and after 15 min. hydrolysis at 100° C. in $N/2$ hydrochloric acid, by the method of Somogyi[2]. It was assumed that the hydrolysable non-reducing sugar was sucrose, and that reducing non-fructose sugar before and after hydrolysis was glucose.

Sugars excreted by aphis on European lime tree

	Gm. sugar/100 gm. leaf or soil			
	Sucrose	Glucose	Fructose	Total sugars
Leaves	12·3	8·3	9·2	29·8
Soil	4·7	1·5	1·4	7·6

The results given in the accompanying table show that the amount of sugars secreted by the aphis on to the leaves of lime trees is surprisingly large, and must amount to several kilograms for an average-sized tree. About half the total solids of both extracts consisted of sugars.

My thanks are due to Prof. C. H. O'Donoghue for his interest in this work.

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[1] Corcoran, A. C., and Page, I. H., *J. Biol. Chem.*, **127**, 606 (1939).
[2] Somogyi, M., *J. Biol. Chem.*, **160**, 61 (1945).

Structure of Cyclopropane

Although I am pleased to note that Dr. A. D. Walsh has made a final contribution to this discussion, it may nevertheless be possible to correct a mis-statement. He says[1] that I take the usual formula to represent only the position in space of the atoms involved. What I actually wrote was[2]: ". . . to the usual formulæ. These represent nothing more than the mode of linking of the atoms in the molecule, combined with an indication of the degree of symmetry of the statistical distribution of electrons". Or again[3]: "The formula represents only the mean position in space of the atoms (kernels) and the mode of binding (that is, the structure disclosed by analysis, synthesis, X-ray crystal evidence, etc.)".

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[1] Walsh, A. D., *Nature*, **160**, 903 (1947).
[2] Robinson, R., *Nature*, **159**, 400 (1947).
[3] Robinson, R., *Nature*, **160**, 162 (1947).

COMPLEXITY OF FRESH *HEVEA* LATEX

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ALTHOUGH under difficult conditions, the work at the Netherlands Indies Rubber Research Institute at Buitenzorg (Java) was continued during the Japanese occupation. Since it will be a long time before the accumulated results of the years 1942–45 can be published in detail, some points of general interest are reported here.

It is common knowledge that upon addition of small amounts of salts of bi- or poly-valent cations to fresh latex, a partial coagulation follows. The yellow-coloured coagulum generally contains 10–30 per cent of the rubber and gives after drying a yellow rubber, rich in proteins and having a high acetone extract. The high acetone extract and the colour are produced by the yellow particles, first observed by Frey-Wyssling, which although generally called 'resin particles', contain mainly lipoids. What, however, is the reason of the high protein content?

In 1941 it was observed by one of us (L. N. S. H.) that when fresh latex is centrifuged in tubes, a separation occurs into a heavy yellow fraction, taking up a tenth to a third of the total volume, and a lighter white fraction. The yellow fraction is more viscous and often in itself consists of various layers, bright yellow, grey yellow, orange or even green coloured. Much information was obtained by studying separately the chemical composition, colloid-chemical and enzymological properties of these fractions.

The difference in composition is evident from the following example:

	Original latex	White fraction	Yellow fraction
Ratio of weight	100	76·3	23·7
Specific gravity	0·977	0·966	?
Viscosity (centipoises)	11·7	9·2	?
Dry rubber content (%)	34·8	43·7	9·0
Total solids (%)	37·4	45·8	14·3
Nitrogen content (%)	0·24	0·22	0·33
Ash content (%)	0·60	0·47	1·11
*p*H (fresh)	6·3	6·9	5·7
Crepes prepared from the sample had:			
Nitrogen content (%)	0·37	0·34	0·73
Ash content (%)	0·15	0·13	0·50
Acetone extract (%)	2·42	2·10	6·99

It is clear that a large part of the non-rubber constituents of the latex assembles in the yellow fraction, whereas the white fraction is a purer rubber dispersion than the original latex. In spite of its higher rubber content, the white fraction is less viscous, even after ammoniation, and consequently it has better creaming properties.

Another important difference is in their behaviour on standing. Whereas the original latex coagulates spontaneously after about twelve hours, the white fraction may stay fluid for days. The yellow fraction, on the other hand, coagulates within a few hours. This probably is a consequence of the fact that all enzymatic reactions in the yellow fraction are much more pronounced than in the white fraction, giving rise to accelerated splitting of large-molecule complexes and the formation of free fatty acids which, in their turn, in the presence of magnesium ions, effect spontaneous coagulation[1]. The addition of a freshly made pancreas lipase extract accelerates the spontaneous coagulation of the yellow fraction considerably, is less active in the original latex and has scarcely any influence on the white fraction.

A clear demonstration of the greater activity of enzymes in the yellow fraction is given by the dark discoloration on the surface, which is caused by oxidizing enzymes. On standing exposed to air, latex sometimes becomes discoloured on the surface, turning grey or greyish-purple. The white fraction never becomes discoloured; but the yellow fraction always becomes dark grey or purplish-black, often very quickly. Gas formation occurs in the yellow fraction earlier and to a much greater extent than in the white fraction.

Microscopic observations. The complexity of fresh latex, caused by the existence of the yellow fraction, is even observable under the microscope provided the latex is examined in a thin layer and with a small magnification (60–200) and that it is not diluted. The rubber dispersion then is visible as a highly absorbent mass; the rubber particles are not visible separately; but the whole mass is constantly glittering and twinkling in consequence of Brownian movement. The yellow fraction, on the other hand, appears as irregular shaped transparent 'islands' with an irregular structure. The great difference in viscosity is evident. By pressing on the cover glass, streaming of the rubber dispersion is easily effected; but the bright 'islands' are viscous and change their shape only slowly and with difficulty. The phenomenon is especially clearly observable in latex from twigs and from young trees, since in such lattices the yellow fraction takes up a large, even the larger, part of the volume.

Stability. In old ammoniated latex the yellow fraction is no longer present. Resin particles may be observed, but not the viscous matter just described. This is easily understood by observing under the microscope the picture which appears when alkali diffuses into fresh latex: the transparent viscous islands dissolve. Sometimes, however, the viscous matter is more resistant and in exceptional cases it was still present in ammoniated latex several weeks old. Not only the amount but also the properties are dependent on all kinds of biological factors, such as age and strain of the tree, place and frequency of tapping; possibly the season, the weather, even the soil may be of influence.

Very much in contrast to the influence of alkali is the action of distilled water. Now the viscous matter may be observed to stiffen and flocculate under the microscope. From this observation puzzling effects such as the rise in viscosity upon dilution of fresh latex with water, and the forming of clots upon dialysing, now become clear. The behaviour of the yellow fraction of *Hevea* latex upon addition of water is analogous to that of *Cryptostegia* latex[2], since coagulation results.

Dilution of the yellow fraction without a change in the consistency of the viscous matter is possible with a salt solution containing a monovalent cation of about 0·1 normality. With such a solution it becomes possible to wash the yellow fraction by repeated centrifuging, decanting and diluting. Moreover, under suitable conditions as to *p*H and the concentration of the monovalent cation, it is possible to separate the yellow fraction without centrifuging

but simply by gravity. The fact that the addition of salt reduces the viscosity of the fresh latex very considerably is one of the reasons for this.

The true nature of the viscous matter in fresh latex is not yet known, but the properties resemble those of coacervates[2] very much; thus it seems probable that fresh latex contains a micro-coacervate which by centrifuging or under favourable conditions as to the viscosity goes over in a macro-coacervate.

The progress of our research work has been slowed down, first by the War and later it was interrupted by the unhappy conditions in Java; it is expected, however, that work at our Institute will be resumed in the near future.

[1] Compare v. Gils, *Arch. Rubbercultuur*, **25**, 395 (1941).
[2] Symontowne, *Ind. Rubb. W.*108,148259 (1943).
[3] See Kruyt and Bungenberg de Jong, *Koll. Z.*, **50**, 39 (1930).

STUDIES IN STOMATAL ACTION

Adequacy of the Porometer in the Investigation of Stomatal Aperture

IN the usual form of porometer a small cup is permanently attached to the leaf surface, air is drawn through the leaf into the cup under reduced pressure and either the rate of air flow is measured[1,2] or, in the 'resistance porometer'[3,4], the fall in pressure across the leaf and also that across a standard capillary resistance in series is found; from these pressure gradients the resistance to flow through the leaf is calculated. The rate of flow or the resistance to flow are functions, though very complex ones, of stomatal aperture. In earlier work porometers were used for the purely qualitative purpose of showing whether the stomata were opening or closing. Interest in the dynamics of stomatal movement[5,6] and in the relation between stomatal movement and carbon assimilation[7,8], however, made it desirable to attempt to estimate from porometer readings the resistance to viscous flow of the stomata alone, thus eliminating the confusing effects of the irrelevant internal resistances in the leaf. Hence, ultimately, making use of the less convenient 'diffusion porometer'[9] to calibrate the 'resistance porometer', the resistance to diffusion through the stomata might be estimated. With this end in view a mathematical theory of porometers was elaborated[10,4] and used to estimate stomatal resistances in *Pelargonium*[4].

During a recent investigation of shock-induced stomatal movements[11], it was found that with stomata open in the light, strips of epidermis taken by Lloyd's[12] method within the cup area showed very much wider apertures than those taken just outside the cup. This was at first attributed to the lack of shock sensitivity of the stomata within the cup[11]. The possibility existed, however, that the stomata outside the cup were not showing 'shock closure' on stripping of the epidermis, but actually had smaller apertures on the intact leaf than those within the cup. This, if true, would have an important bearing on the quantitative use of porometers, for the theory mentioned above demands the assumption that the stomatal apertures are the same inside and outside the cup.

A considerable number of experiments, carried out separately after consultation between us, has left no doubt that illuminated leaves, both of *Pelargonium zonale* and *Triticum vulgare*, have, in fact, much wider stomatal apertures where the surface is enclosed in a cup than elsewhere. This has been shown by a modification of Molisch's[13] injection technique using gentian violet in absolute alcohol (*Pelargonium* and *Triticum*) as well as by Lloyd's method and direct microscopical observation (*Pelargonium*). If part of the lamina of a *Pelargonium* or wheat leaf is merely placed between two glass strips and then, after two or three hours illumination, flooded with alcohol, heavy injection indicating wide open stomata is found where the leaf has been enclosed, and little or none elsewhere. Darkened portions show no injection either within or outside the enclosed area. Similar results are obtained using small chambers resembling porometer cups.

The conditions within a porometer cup differ from those outside in the following respects: (1) The air inside the cup is of restricted volume and at rest between readings (if the porometer is disconnected); it thus rapidly becomes saturated with water vapour, a process which is hastened by the drawing of air from the intercellular space system of the leaf into the cup during readings. In the case of *Pelargonium*, the concentration of ethereal oils must also be higher within the cup; with any species other gaseous substances may diffuse out of the leaf, and the oxygen and carbon dioxide tensions in the cup will also be affected. (2) The upper surface of the leaf above the cup is (normally) touching a glass plate. (3) The temperature within the cup may be slightly higher. (4) The leaf in the cup area is (usually) illuminated from above only, the cup shading the lower surface from any *direct* light.

The possible effects of these differences may now be considered.

(1) Experiments, each with a pair of porometer cups on the same leaf, one cup containing a desiccating agent (silica gel or calcium chloride) and the other empty or with moist broken porous tile, show similar wide stomatal opening in both cups, whether judged by porometer readings or Lloyd's method. These results seem to dispose of high humidity as the factor causing the wide opening within the cup. The ethereal oils of *Pelargonium* also seem unlikely to be important in this respect, for similar effects are found with wheat. The question of other variations in the composition of the air in the cup is discussed elsewhere[14].

(2) It is found that similar wide stomatal opening occurs when *Pelargonium* or wheat plants are enclosed in a bell jar, in a saturated atmosphere, with the leaves not in contact with the glass. Thus pressure of the glass plate on the leaf is not concerned. Similar plants outside the bell jar show little opening except where the leaves are enclosed between glass plates, as above.

(3) In the bell jar experiments just cited the difference in temperature inside and outside does not exceed 1½° C. Thus the differences in aperture can arise in the absence of appreciable temperature differences.

(4) These experiments have been carried out with moderate light intensities—a 100-W. or 150-W. lamp, with running water screen, at 3–7 in. distance. It seems improbable that *reducing* the illumination of the lower surface of the leaf would cause wider stomatal opening. In all cases the usual closing response to darkening the upper surface has been found.

Whatever the cause of the wider opening within the cup, and this is the subject of a further com-

munication from one of us[14], it is essential to overcome it if the porometer is to be used other than to show in a purely qualitative manner whether the stomata are opening or closing. The ideal to aim at is obviously to make the conditions within the cup the same as those outside. This has been to a large extent achieved by a simple modification of the form of resistance porometer used by Heath[4]. Air of the same composition and humidity as that surrounding the leaf is supplied to the porometer at a constant *increased* pressure by a simple aspirator working on the 'gasometer' principle. To avoid alteration of the humidity, medicinal paraffin is used in the aspirator and a light grade of the same in the manometers. As compared with the normal type of resistance porometer the pressure gradients are all reversed, but the manometer readings are used in the usual way, only the signs being changed. A hole in the glass or 'Perspex' plate pressing the leaf against the cup washer leaves all the upper leaf surface above the cup area open to the air. Between readings the cup is swept with a stream of the same air that surrounds the rest of the leaf, and during readings such air is being forced from the cup into the leaf through the stomata. There is therefore no tendency for water vapour or other gaseous substances from the leaf to accumulate in the cup. Using this modification of the porometer, preliminary tests with *Pelargonium* have indicated that the stomal apertures inside and outside the cup, as shown by Lloyd's method, are of similar magnitude. A preferable alternative to sweeping air through the cup would be the use of a detachable cup. Maskell[7], using the smooth-leafed cherry laurel, was able to use a cup with a gelatine washer which was simply pushed against the leaf and could be completely removed between readings. For hairy leaves such as *Pelargonium*, however, it is necessary to use a special design of detachable cup which leaves the washer in position on the leaf between readings. Such cups have been used previously for *Pelargonium* in the Research Institute of Plant Physiology, and the method is at present in use in experiments with wheat. A similar cup will now be tried with *Pelargonium*, which is easier than wheat to examine by Lloyd's method, to see whether it gives similar apertures within and outside the cup area.

It is likely that with readings of short duration a normal (reduced pressure) resistance porometer might safely be used; but the modification described above reduces the risk and does not appear to have any disadvantages. The 'gasometer' type of aspirator, which can, of course, be used for either increased or reduced pressures, has the important advantage over the usual type that there is no bubbling of the air through a liquid and hence the menisci in the manometers are absolutely steady and readings can be made instantaneously.

It should be emphasized that data obtained with the more usual type of porometer and a permanently fixed unswept cup are valid for the enclosed stomata so far as qualitative indication of opening or closure in response to light or darkness is concerned. The stomata within the cup do respond to light, and open much wider than those outside. It may be noted also that when used with double 'leaf chambers'[8], in which a considerable area outside the porometer cup is maintained under identical conditions, the normal type of porometer yields data which as an approximation at least may be treated quantitatively in the manner indicated elsewhere[4].

This work is continuing and will be published in detail in due course.

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[1] Darwin, F., and Pertz, D. F. M., *Proc. Roy. Soc.*, B, **84**, 136 (1911).
[2] Knight, R. C., *New Phyt.*, **14**, 212 (1915).
[3] Gregory, F. G., and Pearse, H. L., *Proc. Roy. Soc.*, B, **114**, 477 (1934).
[4] Heath, O. V. S., *Ann. Bot.*, N.S., **5**, 455 (1941).
[5] Gregory, F. G., and Pearse, H. L., *Ann. Bot.*, N.S., **1**, 3 (1937).
[6] Williams, W. T., Ph.D. Thesis, Univ. Lond. (1940).
[7] Maskell, E. J., *Proc. Roy. Soc.*, B, **102**, 488 (1928).
[8] Heath, O. V. S., *Ann. Bot.*, N.S., **3**, 469 (1939).
[9] Gregory F. G., and Armstrong, J. I., *Proc. Roy. Soc.*, B, **121**, 27 (1936).
[10] Penman, H. L., *Proc. Roy. Soc.*, B, **133**, 416 (1942).
[11] Williams, W. T., *Nature*, **160**, 364 (1947).
[12] Lloyd, F. E., *Pub. Carneg. Inst.*, 82 (1908).
[13] Molisch, H., *Z. Bot.*, **4**, 106 (1912).
[14] Heath, O. V. S., following communication.

Control of Stomatal Movement by a Reduction in the Normal Carbon Dioxide Content of the Air

To account for the much wider stomatal apertures found within a porometer cup than elsewhere on an illuminated leaf[1], the hypothesis was examined that some volatile substance produced by the leaf itself caused opening of the stomata in light when in high concentration. On testing this hypothesis a considerable amount of experimental evidence was obtained in its favour. Thus detached leaves in water of *Pelargonium* or wheat, enclosed together with entire plants in a saturated atmosphere under a bell jar and illuminated for a few hours, showed wide stomatal opening when tested by the injection technique of Williams[1]; single leaves similarly enclosed by themselves, also in a saturated atmosphere and illuminated, showed little or no injection. On the other hand, similar single leaves of wheat each enclosed in a *small* volume of saturated air in a glass tube showed very heavy injection, as in the leaves from the crowded bell jars. When such tubes were swept continuously with a slow stream of humid air, little or no injection of the leaves was found.

The following statistically significant effects were thus obtained: (1) Heavier injection (wider stomatal opening) with many than with few or single leaves in the same large volume of humid still air; (2) heavier injection with single leaves in a small than in a large volume of humid still air; (3) heavier injection with single leaves in a small volume of humid still air than in humid moving air. Porometer experiments with *Pelargonium* showed that sweeping the cup with moving air, whether dry or humid, caused considerable stomatal closure as compared with still air. Similar results have been obtained with wheat, using dry air, by Mr. Milthorpe in this Institute. Darwin's[2] finding that removal of plants from a (presumably crowded) greenhouse to the laboratory caused stomatal closure, but that enclosure of the plants in bell jars caused the stomata to remain open or reopen, also seemed to support the hypothesis, although he himself attributed these effects to humidity changes.

There existed, however, the seemingly remote possibilities that all these effects were due either to

the removal of carbon dioxide or the increase of oxygen concentration brought about by photosynthesis. The crucial experiments were therefore performed of sweeping porometer cups, attached to illuminated leaves of *Pelargonium* and wheat, with either carbon dioxide-free or ordinary air, both dry and humid conditions being investigated. It was at once found that moving carbon dioxide-free air, whether humid or dry, caused stomatal opening, sometimes even where the full opening in still air had been reached. This last implies sensitivity to extremely low carbon dioxide concentrations. Ordinary air at the same rate of flow caused very considerable closure. Rate of sweeping had virtually no effect between one and eight litres per hour (*Pelargonium*), and four litres per hour was adopted as standard. The effects of carbon dioxide-free and ordinary moving air in the dark were also investigated (*Pelargonium*). It was found that although carbon dioxide-free air would *prevent* complete closure in darkness and would also cause partial further opening of stomata which were not completely shut, if the stomata had been completely closed (resistance approx. infinity) by ordinary air they would not reopen in carbon dioxide-free air. This would seem to show that the effect of carbon dioxide is due to its concentration in the sub-stomatal cavities and not at the outer surface of the guard cells. In all these porometer experiments the modified resistance porometer[1] was used; the stomata were allowed to attain their equilibrium opening for each set of conditions before the conditions were altered, except in a few cases with saturated air, in which equilibrium was attained much more slowly than with dry air.

Supporting evidence for the 'carbon dioxide' hypothesis has been obtained from experiments in which single detached leaves of *Pelargonium* or wheat have been enclosed under bell jars, with or without a dish of 2 *N* caustic soda solution, and illuminated for a few hours. Significantly heavier injection has been found for both species in the leaves from the bell jars with caustic soda, the effect being particularly striking with *Pelargonium*.

The porometer experiments not only dispose of the 'volatile substance' hypothesis, for such a substance should be equally swept away by either carbon dioxide-free or ordinary air; they similarly dispose of the 'oxygen' hypothesis. The only remaining possibility, apart from a carbon dioxide effect, seems to be that closure is caused by some other substance present in the air supply. Such a substance would have to be absorbed by caustic soda or soda lime but not by silica gel, phosphorus pentoxide or calcium chloride; nor by a solution of sodium thiosulphate, which was used to remove chlorine from humid air supplied by a water pump. Furthermore, such a substance must be of wide occurrence, for similar partial closure of stomata freely exposed to the air has been found at Bedford College[1,3] and in two laboratories in the Research Institute[1]. In the latter there was no gas supply nor tobacco smoke. On the present evidence, therefore, the 'carbon-dioxide' hypothesis seems by far the most plausible.

The effects of carbon dioxide on stomata have been investigated in a sporadic manner for more than fifty years, but the comparison has almost always been made between carbon dioxide-free or ordinary air and very high concentrations or even pure carbon dioxide. Darwin[2], using his 'horn hygroscope', found that the stomata in light "remain open in an atmosphere free from carbon dioxide". In pure carbon dioxide they were found to close slowly. He criticized Schellenberger's[4] finding, that in carbon dioxide-free air the stomata closed slowly, as being due to the use of relatively dry air; but the present work renders this explanation improbable, and many other factors, such as a diurnal rhythm of stomatal movement[5,6], may have been involved. Lloyd's[7] data for *Verbena ciliata* rather suggest that the stomata do not close readily in darkness in carbon dioxide-free air, but if already shut will remain closed; in light they open in carbon dioxide-free air. These results resemble some of the present findings but Lloyd does not direct attention to them. Linsbauer[8] investigated the effects of carbon dioxide-free air both in light and darkness, and found that in all experiments the removal of carbon dioxide favoured the opening of stomata in the dark. The effect in the light was stated to be the same but less pronounced owing to the stomata being already partly open. These entirely correct results have seemed suspect owing to the very crude technique by which they were obtained, for leaf fragments were held against a moist filter paper over solid caustic potash or a strong solution, and Linsbauer himself noted that the tendency of the leaf fragments to dry gave much trouble. High carbon dioxide concentrations were found to cause closure or failure to open in both light and darkness. Stahl[9] also found that high carbon dioxide concentration caused closure. Scarth[10] investigated the effects of high concentrations of carbon dioxide (10–50 per cent) and found in darkness closure followed after many hours by opening. In the light, opening was prevented. Carbon dioxide-free air was apparently not investigated.

The importance of the findings here reported would seem to lie in the discovery of the extreme sensitivity of the stomata to very small variation in carbon dioxide concentration (between *c.* 0·03 per cent and zero). This is found to furnish a plausible explanation of a number of hitherto obscure phenomena observed in the course of many years research on stomata in this Institute. Such a mechanism may well have the biological advantage for the plant that the stomata tend to close in wind and thus reduce the risk of desiccation due to excessive transpiration. That such stomatal control of transpiration in wind can occur is shown by moving air experiments at present in progress in this Institute, and is strongly suggested by the work of Wrenger[11].

The present work again raises the possibility that the light response of the stomata may be entirely due to the removal of carbon dioxide by photosynthesis, and the dark response to its accumulation inside the leaf, as has been suggested by Stahl[9], Sayre[12], Scarth[13] and others. Clearly, however, not only the carbon dioxide of respiration but the external supply also is of great importance, especially in the light, and much further work is needed.

The mechanism by which the carbon dioxide concentration controls movement of the guard cells also calls for much further investigation. The opening force in the stoma has been shown to be supplied ultimately by the turgor of the guard cells[14], but the intermediate steps between this and the carbon dioxide concentration in the substomatal cavity are quite uncertain. The evidence for the usual starch $\rightleftarrows$ sugar hypothesis, whether controlled through *p*H change or in any other way, is not convincing so far as the dark – light response is concerned[15].

This work will be continued and detailed publication will follow in due course.

O. V. S. Heath

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[1] Heath, O. V. S., and Williams, W. T., previous communication.
[2] Darwin, F., *Phil. Trans. Roy. Soc.*, B, **190**, 531 (1898).
[3] Williams, W. T., *Nature*, **160**, 364 (1947).
[4] Schellenberger, *Bot. Z.*, 169 (1896).
[5] Maskell, E. J., *Proc. Roy. Soc.*, B, **102**, 488 (1928).
[6] Gregory, F. G., and Pearse, H. L., *Ann. Bot.*, N.S., **1**, 3 (1937).
[7] Lloyd, F. E., *Pub. Carneg. Inst.*, 82 (1908).
[8] Linsbauer, K., *Flora*, N.F., **9**, 100 (1916).
[9] Stahl, E., *Flora*, N.F., **13**, 1 (1919).
[10] Scarth, G. W., *Plant Physiol.*, **7**, 481 (1932).
[11] Wrenger, M., *Z. Bot.*, **29**, 257 (1935).
[12] Sayre, J. D., *Ohio J. Sci.*, **26**, 233 (1926).
[13] Scarth, G. W., *Proc. Int. Cong. Plant Sci.*, **2**, 1151 (1929).
[14] Heath, O. V. S., *New Phyt.*, **37**, 385 (1938).
[15] Heath, O. V. S., *Nature*, **159**, 647 (1947).

SOCIAL AND SCIENTIFIC DEVELOPMENT OF THE WEST INDIES

THE considerable report by Sir John Macpherson, recently issued*, contains much valuable information relating to the work of the Development and Welfare Organisation in the West Indies. The report at once conveys an impression of how much is being done (or is under consideration) and how much there is yet to do. The contemporary situation in the West Indian Colonies, whether agricultural, economic, social or political, is complex. It has been long in the making, and wise foresight, good management, patience, industry and optimism will be needed before matters are put right. It is probably true to say that, in this region, there is now a general demand for conditions which will enable the local populations to enjoy a fuller and better life. In practice this means that improvements must be effected in almost every walk of life and in every branch of official activity.

The report opens with an informative general survey of West Indian affairs. Particular attention is given to such topics as agriculture, forestry, fisheries, education, public health, housing, town planning, labour conditions, social welfare, public works, etc. A special Welfare Fund, granted by the Exchequer of the United Kingdom, is available for promoting schemes for the general improvement of education, health services, land settlement, and the hundred-and-one projects which collectively will make for better conditions and opportunities for the native population of the West Indies.

Space does not admit of an adequate review of the contents of this report. But as an example of the treatment accorded to one major theme, agriculture may be selected. Here, as elsewhere, Sir John is direct and to the point. It is most sincerely to be hoped that his words will be heeded throughout the length and breadth of our Caribbean Colonies. The ideas are not new, but it is good to hear them forcibly restated at this time :

"The greatest need of the British West Indies to-day is the most intensive use of the land according to methods of good husbandry, both for export crops and local food crops. In no other way can a growing population be supported or the demands for higher standards of living be met. The intensive and balanced use of the land calls for far-reaching reforms in the basic methods now employed, and for improved education facilities and efficient advisory services. The reforms require special measures, some of which cannot be successfully applied until new knowledge acquired through scientific investigation has been made widely available. The work of the Development and Welfare organisation has been constantly guided by these fundamental facts."

It is heartening to read that the need for soil conservation is being more widely understood, that grass is being introduced as a rotational crop, and that there is an increasing disposition to realize that land, water and forest resources are "the foundation upon which better standards of life can be established".

As improvement in agriculture will necessarily depend on an advance in agricultural education, measures to achieve this end are in hand. Measures to assist peasant agriculture, to promote mixed farming adapted to West Indian conditions, to test communal and co-operative farming, and to improve livestock, etc., each has its place in the new agricultural outlook. The essential place of a wide system of researches, duly co-ordinated, is recognized. This matter has been given much attention, and a number of schemes have already been approved. Some of these, including problems of sugar technology, soil science, the improvement of cacao, genetics of tropical crops, including bananas, etc., will be centred at the Imperial College of Tropical Agriculture in Trinidad, while related investigations will be carried out in some of the other islands because of their special suitability for the work.

These notes give but a small sample of the contents of this document as they relate to agriculture. Attention is also given, in due measure, to the several other major topics mentioned above. The text, clearly but closely written, contains much interesting and valuable detail and should be carefully read by all who follow with interest and sympathy the new movement that is undoubtedly afoot in the Colonies.

* Development and Welfare in the West Indies. By Sir John Macpherson. Col. 212. Pp. 162. (London : H.M. Stationery Office 1947). 3s.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 2

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 2.30 p.m.—Dr. W. G. Ogg : "Soil and the Farmer".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Prof. A. C. Frazer : "The Metabolism of Fats" (Cantor Lecture).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. D. G. Tucker and Mr. F. Scowen : "Modern Approach to Transmission Networks".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. E. E. Turner : Presidential Address.

Tuesday, February 3

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. L. S. Penrose : "Human Genetics".*

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Rev. Prof. E. O. James : "The Social Function of Anthropology".

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1) at 5.15 p.m.—Mr. W. L. Stevens : "Control by Gauging".

CONWAY DISCUSSION CIRCLE (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. J. A. C. Brown : "Group Psychology in Industry".*

Wednesday, February 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Lieut.-Colonel L. Urwick: "Education for Management".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. H. H. Merriman and Mr. R. W. White: "The Application of Frequency Modulation to V. H. F. Multi-Channel Radio-telephony".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP of the INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. K. Brownlee: "The Design of Experiments with Special Reference to the Chemical Industry".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Messrs. D. W. Kent-Jones, A. J. Amos, P. S. Elias, R. C. A. Bradshaw and G. B. Thackray: "The Micro-analytical Test for Purity in Food, with special reference to Cereals".

Thursday, February 5

ROYAL SOCIETY OF ARTS, INDIA AND BURMA SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Colonel D. J. Atkinson: "The Forests and Forests Resources of Burma".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. C. H. Kellaway, F.R.S.: "The Wellcome Research Institution".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, February 6

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (at the College of Technology, Manchester), at 3 p.m.—Annual General Meeting: Dr. D. T. A. Townend: "Coal Utilisation".

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. M. Blackman and Mr. J. L. Michiels: "Efficiency of Counting Systems"; Mr. N. F. Astbury: "The Moving-Coil Galvanometer as a Circuit Element".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. G. N. Harvey: "A New System of Compass Correction".

KING'S COLLEGE (Strand, London, W.C.2), at 5.30 p.m.—Prof. I. L. Kandel: "American Universities and their Place in American Life".*

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. W. N. Croft: "A Year in Graham Land".

ROYAL STATISTICAL SOCIETY, LONDON GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. Geiss: "Quality Control in Europe".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, 17 Albert Square, Manchester), at 6 p.m.—Dr. Herbert Levinstein: "Raw Materials for Rayon".

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. D. E. Edmundson: "Magnetic Materials as Applied to Instruments".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Prof. S. Loria and Mr. J. G. Crowther: "Science in Poland".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (joint meeting with the GLASGOW SECTION of the S.C.I., at Glasgow).—Mr. A. G. White: "The Manufacture of Explosive Substances".

Saturday, February 7

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. H. J. Fleure, F.R.S.: "Ploughs and Soils—a Study of some Foundations for European Life".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER IN AERODYNAMICS, a SENIOR LECTURER IN MATHEMATICS, a RESPONSIBLE LECTURER IN PHYSICS, a LECTURER IN MECHANICAL ENGINEERING, a LECTURER IN PRODUCTION ENGINEERING, and a RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (February 7).

PRINCIPAL OF THE SCHOOL OF ELECTRONICS, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs, quoting 5/138/JFA (February 7).

SENIOR LECTURER IN PHYSICS AND ELECTRONIC ENGINEERING at the School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs quoting 5/138/JFA (February 9).

LECTURERS (2) IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (February 14).

EXPERIMENTAL OFFICER (graduate with knowledge of field plot technique and statistical analysis of experimental results), HORTICULTURAL ADVISERS (2, with recognized qualifications in horticulture), and INSTRUCTRESSES IN DAIRYING AND POULTRYKEEPING (2, with recognized qualifications in these subjects)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 14).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Sheffield (February 21).

PHYSICIST IN THE DEPARTMENT OF METEOROLOGY—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (February 21).

LECTURERS IN MATHEMATICS AND SCIENCE (including physics, mechanical or electrical engineering, chemistry, or biology)—The Director of Studies, Royal Military Academy, Sandhurst, Camberley, Surrey (February 21).

SENIOR RESEARCH OFFICER IN THE TOBACCO BRANCH of the Division of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 27).

ASSISTANT TECHNICAL OFFICERS (2) IN THE ROYAL MINT—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2091 (February 28).

LECTURER IN STATISTICS in University College, Dundee, and in the Conjoint Medical School, Dundee—The Secretary, The University, St. Andrews (February 28).

CHAIR OF GENETICS—The Secretary, The University, Edmund Street, Birmingham 3 (March 8).

READERSHIP IN PHYSICS at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 9).

PROFESSOR AND HEAD OF METALLURGY DEPARTMENT, Indian Institute of Science, Bangalore—The High Commissioner for India, India House, Aldwych, London, W.C.2 (Bangalore, March 10).

LECTURER IN ECONOMIC STATISTICS in the Faculty of Economics, University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, March 31).

SCIENTIFIC OFFICER (University graduate with 1st or 2nd class honours in Chemistry) IN THE SPECTROGRAPHIC DEPARTMENT—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

CHEMIST in connexion with the study of problems of fruit and vegetable preservation—The Director, University of Bristol Research Station, Campden, Glos.

RESEARCH CHEMIST—The Director of Research, Research Association of British Flour-Millers, Cereals Research Station, St. Albans, Herts.

SENIOR RESEARCH CHEMIST, a SENIOR TECHNOLOGICAL CHEMIST, JUNIOR RESEARCH CHEMISTS, and a JUNIOR RESEARCH PHYSICIST—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

DIVISIONAL ANALYST, and SCIENTIFIC TECHNOLOGISTS (or Grade III Scientists), in the Coke Oven Laboratories—The Divisional Chief Scientist, National Coal Board (South-Western Division), Ystrad Mynach, Hengoed, Glamorgan.

CHEMISTS AND PHYSICISTS—The Director, Research Association of British Paint, Colour and Varnish Manufacturers, Paint Research Station, Waldegrave Road, Teddington, Middx.

AGRICULTURAL ZOOLOGIST in the Malayan Union—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Board of Trade. Working Party Reports—Wool. Pp. vii + 232. (London: H.M. Stationery Office, 1947.) 3s. 6d. net. [13

Physical Society. Catalogue of the Thirty-first Exhibition of Scientific Instruments and Apparatus, April 1947. Pp. 298 + A8. (London: Physical Society, 1947.) To non-Members, 5s. net. [15

Institution of Mining and Metallurgy. Annual Report of the Council. Pp. 16. Presidential Address on Geographic Changes in Mineral-Producing Centres, delivered at the Annual General Meeting of the Institution on 15th May 1947. By W. R. Jones. Pp. 9. (London: Institution of Mining and Metallurgy, 1947.) [15

British Rubber Producers' Research Association. Publication No. 76: The Interaction between Rubber and Liquids, 8, A New Examination of the Thermodynamic Properties of the System Rubber–Benzene. By Geoffrey Gee and W. J. C. Orr. Pp. 12. Publication No. 79: The Interaction between Rubber and Liquids, 9, The Elastic Behaviour of Dry and Swollen Rubbers. By Geoffrey Gee. Pp. 14. Publication No. 80: The Structure of Polyisoprenes, 6, An Investigation of the Molecular Structure of Dibenzyl by X-Ray Analysis. By G. A. Jeffrey. Pp. 16. (London: British Rubber Producers' Research Association, 1947.) [16

Other Countries

Malayan Forest Records. No. 14: Dipterocarp Timbers of the Malay Peninsula. By H. E. Desch. Pp. x + 171 + 63 plates. 7.50 dollars; 17s. 6d. No. 15: Manual of Malayan Timbers. By H. E. Desch. Vol. 1. Pp. vii + 328 + 69 plates. 10 dollars; 24s. No. 16: Forester's Manual of Dipterocarps. By C. F. Symington. Pp. xiii + 244. 10 yen. (Kuala Lumpur: Director of Forestry, 1941–1942.) [12

Sveriges Geologiska Undersökning. Ser. C, No. 477: Agnostides of the Middle Cambrian of Sweden. By A. H. Westergård. Pp. 140 + 16 plates. 5 kr. Ser. C, No. 478: Blekingemoränens blockhalt. Av G. Lundquist. Pp. 20. 1 kr. Ser. C, No. 479: Svenska stenindustriorsrådet 1–2. Gatsten och kansten, 1. Allmän översikt; 2, Special undersökning av det för 1937 års granitutredning insamlade materialet. Av Bror Asklund. Pp. 187 + 8 plates. 5 kr. Ser. C, No. 480: The Classification of the Hornblendes and the Solid Solution Relations in the Amphibole Group. By N. Sundius. Pp. 36. 2 kr. Ser. C, No. 481: Nya bidrag till kännedomen om Härnögrytjan. Av Henr. Munthe. Pp. 16. 1 kr. (Stockholm: P. A. Norstedt and Söner, 1946–1947.) [12

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Plankton, Bind 4, Nr. 1: Reproduction and Larval Development of Danish Marine Bottom Invertebrates, with Special Reference to the Planktonic Larvae in the Sound (Øresund.) By Gunnar Thorson (with a section on Lamellibranch Larvae, by C. Barker Jørgensen). Pp. 523. (København: C. A. Reitzels Forlag, 1946.) [12